Series 1938, No. 2 Issued July 1942

Soil Survey

Warren County North Carolina

By
W. A. DAVIS
North Carolina Agricultural Experiment Station and
North Carolina Department of Agriculture, in Charge
and
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United States Department of Agriculture

UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF PLANT INDUSTRY
In cooperation with the
North Carolina Agricultural Experiment Station
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SOIL SURVEY OF WARREN COUNTY, NORTH CAROLINA

By W. A. DAVIS, North Carolina Agricultural Experiment Station and North Carolina Department of Agriculture, in Charge, and K. V. GOODMAN, A. J. VESSEL, and W. J. MORAN, Division of Soil Survey,[1] Bureau of Plant Industry, United States Department of Agriculture

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United States Department of Agriculture in cooperation with the North Carolina Agricultural Experiment Station and the North Carolina Department of Agriculture.

CONTENTS

HOW TO USE THE SOIL SURVEY MAP AND REPORT

The soil survey map and report of Warren County, N. C., contain information—both general and specific—about the soils, crops, and agriculture of the county. They are prepared for the general public and are designed to meet the needs of a wide variety of readers. The individual reader may be interested in some particular part of the report or in all of it. Ordinarily he will not have to read the entire report to gain the information he needs.

Readers of soil survey reports may be considered as belonging to three general groups: (1) Those interested in limited areas, such as communities, farms, and fields; (2) those interested in the county as a whole; and (3) students and teachers of soil science and related agricultural sciences. An attempt has been made to satisfy the needs of these three groups by making the report a comprehensive reference work on the soils and their relation to crops and agriculture.

The readers whose chief interest is in limited areas, such as some

[1] The field work for this survey was done while the Division was a part of the Bureau of Chemistry and Soils.

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particular locality, farm, or field, include the farmers, agricultural technicians interested in planning operations in communities or on individual farms, and real-estate agents, land appraisers, prospective purchasers and tenants, and farm loan agencies. The first step of a reader in this group is to locate on the map the tract with which he is concerned. The second step is to identify the soils on the tract. This is done by locating in the legend on the margin of the map the symbols and colors that represent the soils in the area. The third is to locate the name of each soil in the table of contents, which refers the reader to the page or pages in the section on Soils and Crops where each soil is discussed in detail. Under the soil type heading he will find a description of the soil and information as to its suitability for use and its relationship to crops and agriculture. He also will find useful information in the sections on Productivity Ratings and on Land Uses and Agricultural Methods.

The second group of readers includes persons who are interested in the county as a whole, such as those concerned with land-use planning, or the placement and development of highways, power lines, docks, urban sites, industries, community cooperatives, resettlement projects, private or public forest areas, recreational areas, and wildlife projects. The following sections are intended for such users: (1) County Surveyed, in which such topics as physiography, vegetation, water supply, population, and cultural developments are discussed; (2) Agricultural History and Statistics, in which a brief history of the agriculture is given and the present agriculture is described; (3) Productivity Ratings, in which the productivity of the soils is given and a grouping of soils according to their relative physical suitability for agricultural use is presented, and (4) Land Uses and Agricultural Methods, in which the present use and management of the soils are described, their management requirements are discussed, and suggestions for improvement in management are made.

The third group of readers includes students and teachers of soil science and allied subjects, such as crop production, forestry, animal husbandry, economics, rural sociology, geography, and geology. The teacher or student of soils will find the section on Morphology and Genesis of Soils of special interest. He will also find useful information in the section on Soils and Crops, the first part of which represents the general scheme of classification and a discussion of the soils from the point of view of the county as a whole, and the second part presents a detailed discussion of each soil. If he is not already familiar with the classification and mapping of soils, he will find that discussed in Soil-Survey Methods and Definitions. The teachers of other subjects will find the sections on County Surveyed, Agricultural History and Statistics, and Productivity Ratings, and the first part of the section on Soils and Crops of particular value in determining the relationships between their special subjects and the soils in the county. Soil scientists or students of soils as such will find their special interest in the section on Morphology and Genesis of Soils.

COUNTY SURVEYED

Warren County is in the northeastern part of North Carolina, along the Virginia State line (fig. 1). It has an area of 443 square

miles, or 283,520 acres. Warrenton, the county seat, is 50 miles (by airline) northeast of Raleigh, the State capital, and about 90 miles southwest of Richmond, Va.

The county lies wholly within the Piedmont Plateau, a broad plateau dissected by the valleys of numerous streams. The streams have cut their valleys from 25 to about 75 feet below the general level of the smoother upland plateau, and the width of the valleys ranges from about ¼ to 1½ miles. The underlying rock formations are mainly granite, gneiss, and schist.

Warren County has about as smooth a relief as any county in the piedmont section of the State. The county is characterized by three distinct classes of relief: (1) Broad interstream areas; (2) sloping, rolling to strongly rolling, or steeply sloping areas; and (3) flat areas in the first bottoms and second bottoms.

The broad interstream areas range in relief from almost level or undulating to gently sloping or gently rolling. Some of the broad smooth areas occur in the vicinity of Warren Plains, Wise, and Manson. Apparently these areas represent the original plain.

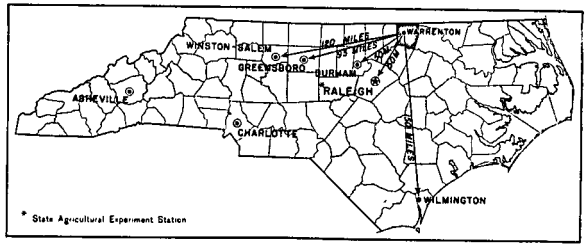

FIGURE 1.—Sketch map showing location of Warren County, N. C.

Bordering these smooth areas and extending to the flat areas along the streams are strongly sloping to strongly rolling areas. The soils on these steeper areas that have been under clean cultivation have undergone considerable erosion. Some of the land on the steeper slopes never should have been cleared of its native vegetation.

Narrow and, in many places, long strips of first-bottom land border practically all of the streams, whereas wider areas of first-bottom land and small areas of second bottoms or terraces occur along the Roanoke River. All areas in the first bottoms and second bottoms are dominantly flat or almost level with a gentle slope in the direction of the streams.

All the soils of the uplands, except in a few small spots here and there, are naturally well drained and on the steeper slopes are excessively drained. The soils in the first bottoms range from well drained to very poorly drained. The main drainageways are the Roanoke River and Fishing, Little Fishing, Shocco, Little Shocco, and Reedy Creeks. Other creeks and streams are Smith, Blue Mud, Hawtree, Sixpound, Hubquarter, Stonehouse, and Bens. Most of the streams are swift-flowing, and in places dams have been constructed and water power developed for running gristmills and sawmills. Practically every farm is directly or indirectly connected with one or more of these natural drainageways.

Elevations above sea level, as shown by the United States Coast and Geodetic Survey, are 425 feet at Manson, 437 feet at Norlina, 383 feet at Wise, 386 feet at Macon, and 377 feet west of the Seaboard Air Line Railway station at Littleton.

The native vegetation consisted mainly of hardwood and pine on the uplands and gum in the more poorly drained areas. Practically all of the merchantable timber from the original growth has been cut, and in some places the second-growth timber has been cut. The present forest growth consists mainly of second-growth pine (old-field pine), post oak, red oak, white oak, black oak, maple, tuliptree (yellow poplar), hickory, and a few birch. Within a few years the pine in many places will produce merchantable timber. There is a scattered undergrowth of redbud, sweetgum, dogwood, sassafras, and holly.

Warren County was formed from Granville County in 1779. Most of the early settlers were English, and some were of Scotch ancestry. According to the 1940 census, the population numbers 23,145, or 54.5 persons a square mile, all classed as rural. There is a large Negro population. The composition of the population for 1940 is not yet available (1941), but the composition in 1930 was 36.2 percent native white, 0.3 percent foreign-born white, and 63.5 percent Negro. Except for the towns, the population is fairly well distributed over the county. Warrenton, the county seat, had a population of 1,147 in 1940. Other towns are Norlina, Wise, Ridgeway, Manson, Afton, Warren Plains, Macon, and Vaughan. Littleton, part of which is in Halifax County, and Drewry, just over the line in Vance County, serve as trading centers for areas in this county. The main line of the Seabord Air Line crosses the county, and the Norfolk branch of this system leaves the main line at Norlina. Warrenton and Warren Plains are connected by the Warrenton Railroad. United States Highway No. 1 crosses the northwestern part of the county and No. 158 crosses from east to west in the central part. There are also three State highways. County roads extend to all parts, and, with the exception of a few days during the winter or during excessive rains, they are generally good. Churches and schoolhouses are established at convenient locations. Many formerly small schools have been combined, and the pupils are transported to the consolidated schools in busses. Rural mail routes reach all parts of the county, and telephone service is available in many parts. Rural electrification is spreading.

Practically all of the cotton is sold locally and shipped either by truck or by railroad to distant mills. The principal outside markets for tobacco are Henderson in Vance County and Rocky Mount in Edgecombe and Nash Counties. Warrenton has a small cotton mill and a box factory. Small sawmills are scattered over the county.

CLIMATE

The climate of Warren County is oceanic; that is, it is affected by the proximity of the Atlantic Ocean. The summers are long and usually hot, and the winters are short and not very severe.

As no United States Weather Bureau station is located in Warren County, climatic data are taken from records compiled at Henderson, Vance County, about 15 miles southwest of Warrenton. These data are fairly representative of conditions in Warren County.

The extreme range in temperature is 108° F. There are a few days in the winter when the temperature is below freezing. The temperature is sufficiently mild for the growing of winter cover crops and

hardy vegetables, such as collards and turnips. The average frost-free season is 204 days (from April 10 to October 31), which is sufficient for maturing the crops commonly grown. The latest and earliest recorded killing frosts occurred on April 28 and October 8, respectively.

The average rainfall of 46.30 inches is ample for the production of all the common crops and is well distributed during the growing season. The driest period occurs from September to December, thus giving excellent weather for harvesting crops and for sowing oats, wheat, and cover crops. The climate is favorable for the production of corn, cotton, bright-leaf tobacco, wheat, rye, oats, hay crops, peanuts, sweetpotatoes, potatoes, sorgo, fruits, melons, garden vegetables, and a variety of leguminous crops.

Table 1 gives the normal monthly, seasonal, and annual temperature and precipitation, as recorded at the United States Weather Bureau station at Henderson.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Henderson, Vance County, N. C.*

[Elevation, 435 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1921)	Total amount for the wettest year (1934)	Snow, average depth
	°F.	°F.	°F.	*Inches*	*Inches*	*Inches*	*Inches*
December	41.4	81	0	3.70	2.62	1.58	2.1
January	40.9	78	2	3.23	3.20	2.07	2.6
February	42.3	82	−2	3.56	2.72	5.23	3.5
Winter	41.5	82	−2	10.49	8.54	8.88	8.2
March	50.3	92	8	4.07	2.53	8.50	1.7
April	57.9	98	20	3.65	1.23	6.11	.4
May	67.6	98	37	3.84	3.17	6.30	.0
Spring	58.6	98	8	11.56	6.93	20.91	2.1
June	74.7	101	41	4.54	3.40	3.05	.0
July	78.1	106	50	5.19	2.37	10.21	.0
August	76.9	104	48	5.43	.62	2.75	.0
Summer	76.6	106	41	15.16	6.39	16.01	.0
September	71.9	103	40	3.46	2.81	4.05	.0
October	60.2	97	25	3.21	1.42	.71	(1)
November	49.9	85	12	2.42	2.70	9.55	.3
Fall	60.7	103	12	9.09	6.93	14.31	.3
Year	59.3	106	−2	46.30	28.79	60.11	10.6

[1] Trace.

AGRICULTURAL HISTORY AND STATISTICS

The early agriculture consisted mainly of the production of corn and small grains, together with the raising of some sheep, hogs, and cattle. Cotton and tobacco became important crops about 1850. The plantation system of farming prevailed until the Civil War. After the Civil War cotton became the principal crop. Later tobacco became an important cash crop.

Table 2, compiled from the reports of the Federal census, gives the acreage devoted to the principal crops in stated years.

TABLE 2.—*Acreage of principal crops in Warren County, N. C., in stated years*

Crop	1879	1889	1899	1909	1919	1929	1939
	Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
Corn	28,457	22,172	26,975	25,230	22,265	17,401	19,098
Wheat	5,098	3,447	2,350	1,357	2,003	894	3,285
Oats:							
Threshed	5,559	6,098	2,982	1,068	345	82	397
Cut and fed unthreshed						1,334	393
Potatoes		82	78	124	164	275	294
Sweetpotatoes	383	610	633	829	474	376	578
Peanuts		9	117	719	351	145	688
Beans (mainly soybeans)			49	19	64	246	267
Peas (mainly cowpeas)			929	1,312	1,393	493	1,580
Cotton	21,603	19,970	18,275	20,598	19,023	29,008	14,165
Tobacco	1,759	2,153	3,513	2,632	7,903	6,680	7,095
All hay	139	805	846	1,833	4,763	1,717	8,344
Sweetclover and lespedeza						382	3,128
Legumes for hay					2,244	457	2,676
All other hay					2,519	878	2,540
	Trees	*Trees*	*Trees*	*Trees*	*Trees*	*Trees*	*Trees*
Apples [1]		17,017	32,658	22,803	17,948	15,780	12,992
Peaches [1]		19,848	14,497	16,382	6,587	10,572	11,345

[1] Fruit trees are for the years 1890, 1900, 1910, 1920, 1930, and 1940, respectively.

The acreages of corn, wheat, and oats decreased considerably from 1879 to 1929. During the same period the acreage of cotton and especially that of tobacco increased markedly. During the last 10 years, however, a reduction of about 14,800 acres in cotton has been offset by an increase of about 9,000 acres in corn and hay crops, corresponding with an increased number of cattle and hogs, and by increases in the acreages of tobacco, wheat, sweetpotatoes, beans, and peas.

At present the agriculture of Warren County consists chiefly of the production of tobacco, cotton, and, to some extent, cantaloups, as cash crops; whereas corn, small grains, hay, and garden vegetables are subsistence crops. Tobacco and cotton are the main cash crops, and on these crops depends the economic condition of the majority of the farmers. Most of the tobacco is used in the manufacture of cigarettes.

Corn occupies the largest acreage of any crop. It is used mainly to feed work animals, to fatten hogs, and to grind into meal for home consumption. Wheat is grown but not in sufficient quantities to supply the local demand for flour. On practically every well-established farm there are a few apple, peach, and pear trees.

The importance of cotton and tobacco in the farm economy may be judged from the following tabulation of all products sold, traded, or used by operators' families in 1929:

Crops sold or traded (mainly cotton and tobacco)	$2,103,466
Livestock sold or traded	46,154
Livestock products sold or traded	70,096
Forest products sold	43,793
Farm products used by operator's family	513,898
Total sold, traded, or used on the farm	2,777,407

According to the Federal census, the number of cattle over 3 months of age on April 1, 1940, was 5,686, as compared with 3,912 on April

1, 1930. The production of milk increased from 937,713 gallons in 1929, when 2,403 cows were milked, to 1,223,016 gallons in 1939, when 3,113 cows were milked.

The number of swine over 4 months of age on April 1, 1940, was 5,437, as compared with 4,378 over 3 months of age on April 1, 1930. There were 1,402 horses and 2,982 mules over 3 months of age on farms on April 1, 1930; whereas on April 1, 1940, there were 579 horses and 3,138 mules.

Poultry products showed little change during this period. In 1929, 136,939 chickens were raised and 259,705 dozen eggs produced. Comparable data in 1939 were 162,971 chickens raised and 271,397 dozen eggs produced.

Both home-mixed and commercial fertilizers are used. The expenditure for fertilizer, including lime, in 1929 was $377,088, or an average of $137.62 a farm, with 94.8 percent of the farms reporting its use. The grades in general use are 3–8–3,[2] 4–8–4, 3–8–5, and 3–8–6.

Farm labor is mostly native white and Negro. Farm hands when hired by the day receive $1 without board, and when hired by the month they receive from $15 to $20 with board, a house, and a garden lot. Farm laborers received total wages of $103,017 in 1929, an average of $109.48 on each of the farms reporting the hire of labor, which were 32.6 percent of all farms.

There were 2,558 farms in 1940. Most of the farms range in size from a few acres to 140 acres. According to the 1940 census the average-sized farm was 81.2 acres, an increase of 20 acres since 1930. The average size in 1880 was 114 acres.

The 1940 census reports 49.1 percent of the farms operated by owners, 50.8 percent by tenants, and 0.1 percent by managers. The general system of share rental is for the landlord to furnish work animals, farming implements, seed, and one-half of the fertilizer. His share is one-half of the crop. When the landlord furnishes all the fertilizer, work animals, seed, and implements, he receives two-thirds of the crop. A few farms are rented for cash.

Farms occupied 207,782 acres in 1940, or 73 percent of the area of the county. Of the farm land 59,592 acres represented cropland harvested in 1939, 755 acres land on which crops were a failure, 8,959 acres idle or fallow land, and 6,927 acres plowable pasture—a total of 76,233 acres available for crops. Other land in farms included 113,389 acres of woodland and 18,160 acres of all other land.

The average value of land and buildings per farm was $1,935 in 1930 and $2,132 in 1940, and the average value per acre was $31.60 and $26.24, respectively.

SOIL-SURVEY METHODS AND DEFINITIONS

Soil surveying consists of the examination, classification, and mapping of soils in the field.

The soils are examined systematically in many locations. Test pits are dug, borings are made, and exposures, such as those in road or railroad cuts, are studied. Each excavation exposes a series of distinct soil layers or horizons, called collectively the soil profile. Each

[2] Percentages, respectively, of nitrogen, phosphoric acid, and potash.

horizon of the soil, as well as the parent material beneath the soil, is studied in detail, and the color, structure, porosity, consistence, texture, and content of organic matter, roots, gravel, and stone are noted. The reaction of the soil [3] and its content of lime are determined by simple tests. Drainage, both internal and external, and other external features, such as the relief or lay of the land, are taken into consideration, and the interrelation of the soil and vegetation is studied.

The soils are classified according to their characteristics, both internal and external, special emphasis being given to the features that influence the adaptation of the land for the growing of crop plants, grasses, and trees. On the basis of these characteristics, soils are grouped into classification units, the three principal of which are (1) series, (2) type, and (3) phase. Some areas of land, such as coastal beach or bare rocky mountainsides, that have no true soil, and mixed material, such as alluvial soils (Congaree soil material), are called (4) miscellaneous land types.

The most important group is the series, which includes soils having the same genetic horizons, similar in their important characteristics and arrangement in the soil profile, and developed from one type of parent material. Thus, the series includes soils having essentially the same color, structure, and other important internal characteristics, the same natural drainage conditions, and the same range in relief. The texture of the upper part of the soil, including that commonly plowed, may differ within a series. The soil series are given names of places or geographic features near which they were first found. Cecil, Appling, Durham, and Congaree are names of important soil series in this county.

Within a soil series are one or more types, defined according to the texture of the upper part of the soil. Thus, the class name of the soil texture, such as sand, loamy sand, sandy loam, loam, silt loam, clay loam, silty clay loam, and clay, is added to the series name to give the complete name of the soil type. For example, Cecil sandy loam and Cecil clay loam are soil types within the Cecil series. Except for the texture of the surface soil, these soil types have approximately the same internal and external characteristics. The soil type is the principal unit of mapping, and because of its specific character it is usually the soil unit to which agronomic data are definitely related.

A phase of a soil type is recognized for the separation of soils within a type differing in some minor soil characteristic that may, nevertheless, have an important practical significance. Differences in relief, stoniness, and the degree of accelerated erosion are frequently shown as phases. For example, within the normal range of relief for a soil type, some areas may be adapted to the use of machinery and the growth of cultivated crops, and others may not. Even though no important differences are apparent in the soil itself or in its capability for the growth of native vegetation throughout the range in relief, there may be important differences in respect to the growth of cultivated plants. In such an instance the more

[3] The reaction of the soil is its degree of acidity or alkalinity, expressed mathematically as the pH value. A pH value of 7 indicates precise neutrality; higher values, alkalinity; and lower values, acidity.

sloping areas of the soil type may be segregated on the map as a sloping or a hilly phase. Similarly, soils having differences in stoniness may be mapped as phases even though these differences are not reflected in the character of the soil or in the growth of native plants.

The soil surveyor makes a map of the county or area, showing the location of each of the soil types, phases, complexes, and miscellaneous land types, in relation to roads, houses, streams, lakes, section and township lines, and other local cultural and natural features of the landscape.

SOILS AND CROPS

Warren County lies on the eastern edge of the Piedmont Plateau. The relief is as gentle as that of any other county on this plateau in the State, and large areas of soils are undulating, gently rolling, or gently sloping. Natural surface drainage and internal drainage are good for all the soils of the uplands with the exception of a few small areas of Worsham sandy loam. Some of the soils in the first bottoms are poorly drained.

The soils are varied in color, texture, structure, and consistence, in both the surface soil and the subsoil. The surface soils range from very light gray or grayish-yellow sandy-textured material to red clay loam. All the soils of the uplands are dominantly low in organic matter and are leached of their soluble mineral plant nutrients. Most of these soils have been used for the production of clean-cultivated crops, especially tobacco and cotton. All the soils are acid to strongly acid in reaction.

The more important soil types are well distributed over the county, and there are no extensive belts of any particular soils. The largest areas are occupied by Cecil sandy loam; Cecil fine sandy loam; Cecil fine sandy loam, eroded phase; Cecil clay loam; Cecil clay loam, hilly phase; Appling sandy loam; and Appling fine sandy loam. Cecil very fine sandy loam and Appling very fine sandy loam occur in the southeastern part of the county, east and south of Arcola. The Durham soils are distributed over the county but more particularly in the central and western parts. The Helena, Wilkes, and Worsham soils occur in comparatively small widely distributed areas throughout the county.

The soils of the uplands have developed through the soil-forming processes from the weathered products of granite, gneiss, and schist. These rocks are composed principally of quartz, orthoclase, and mica. They contain a large proportion of potash, and there is a fairly large quantity of potash in the subsoil. The coarser textured soils, such as the Appling, Durham, and Cecil sandy loams, are developed from granite and gneiss. The fine and very fine sandy loams of these series are underlain by fine-grained gneiss and schist. The Helena and Wilkes soils are developed from aplitic granite, which is cut in some places by basic rocks. Altavista fine sandy loam is the only soil that occurs on second bottoms. This soil is developed from old alluvial materials laid down by the Roanoke River. The Congaree, Wehadkee, and alluvial soils (Congaree soil material) have been formed from more recent sediments washed from the uplands and deposited by the streams. Some quartz gravel is scattered here and there over the surface, and granite outcrops in some places.

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The Cecil soils cover a large part of the county. They include soils with both light-colored light-textured surface soils and red clay loam surface soils. They have uniformly red stiff brittle clay subsoils. The Durham soils are characterized by light-colored sandy-textured surface soils and yellow moderately friable clay subsoils. The Appling soils are easily distinguished from either the Cecil or the Durham by the intermediate color of the subsoils.

Since the soils of Warren County were cleared of their original hardwood forest, considerable changes have taken place in the surface soil as a result of sheet erosion. Practically all of Cecil clay loam originally had a covering of sandy loam or fine sandy loam, but it has been removed by erosion. Both sheet and gully erosion have been and still are active in the clean-cultivated fields. Erosion has almost ruined many areas of once productive soils. Many of the steep slopes never should have been cleared, or, if cleared, they should have been seeded to pasture grasses. Many areas on these slopes were farmed, became eroded, were abandoned, and have grown up to old-field pine. Considerable erosion, particularly gully erosion, took place between the time the land was abandoned and when vegetation started. Much of the soil in the first bottoms along the streams was once the most productive soil in the county. Owing to erosion from the hillsides, stream channels in many places have been partly filled or filled with this washed-in material. In places it has spread out over the good land. This is particularly true of the areas of alluvial soils (Congaree soil material).

About 28 percent of the land in Warren County is under cultivation, and about 14 percent in pasture. Some of the land farmed in the last few years has been abandoned and is now covered with broomsedge or supports a young growth of old-field pine. For a long time the farmers have recognized certain differences in their soils that affect adaptation to crops. The light-colored sandy loams, particularly those of the Durham and Appling series, as well as some of the Cecil soils, are considered the best soils for the production of bright-leaf tobacco. The sandy soils are also favored for the growing of cotton, although the clay loam also produces good crops. Cotton is and has been grown on practically every well-drained soil of the uplands. Cecil clay loam is recognized as the best soil of the uplands for small grains and pasture grasses. The well-drained soils in the first bottoms are used for the production of corn and hay crops, whereas some of the poorly drained areas are devoted to summer pasturage.

The greater part of the tobacco is grown in the northwestern and western parts of the county on soils especially well adapted to its growth, but some tobacco is grown in all parts and in some places on soils not well suited to its production. The best yields of cotton are obtained on the well-drained sandy soils that have been properly fertilized or manured. Corn is grown to a greater or less extent on practically all of the soils in the county, and Congaree silt loam produces the highest yields. Wheat is grown on the Cecil and Appling soils. Garden vegetables are successfully grown on most of the soils, especially if they are fertilized or manured.

In the following pages the soils of Warren County are described in detail, and their agricultural relationships are discussed; their dis-

tribution is shown on the accompanying soil map; and table 3 gives their acreage and proportionate extent.

TABLE 3.—*Acreage and proportionate extent of the soils mapped in Warren County, N. C.*

Type of soil	Acres	Percent	Type of soil	Acres	Percent
Cecil sandy loam	24,384	8.6	Durham fine sandy loam	3,008	1.1
Cecil fine sandy loam	17,664	6.2	Helena fine sandy loam	7,744	2.7
Cecil fine sandy loam, eroded phase	47,936	16.9	Wilkes sandy loam	15,424	5.5
Cecil very fine sandy loam	576	.2	Worsham sandy loam	128	(1)
Cecil clay loam	24,640	8.7	Altavista fine sandy loam	768	.3
Cecil clay loam, hilly phase	32,256	11.4	Congaree silt loam	4,416	1.6
Appling sandy loam	40,512	14.3	Congaree silty clay loam	1,216	.4
Appling sandy loam, slope phase	7,040	2.5	Congaree fine sand	576	.2
Appling sandy loam, gravelly phase	1,792	.6	Wehadkee silt loam	1,728	.6
Appling fine sandy loam	29,632	10.5	Wehadkee fine sandy loam	320	.1
Appling very fine sandy loam	6,080	2.1	Alluvial soils (Congaree soil material)	9,344	3.3
Durham sandy loam	6,336	2.2	Total	283,520	100.0

[1] Less than 0.1 percent.

Cecil sandy loam.—In cultivated fields the surface soil of Cecil sandy loam is grayish-yellow or light grayish-brown mellow sandy loam, from 4 to 6 inches thick. This material grades into a 1- to 3-inch layer of yellowish-brown or reddish-yellow sandy clay that is the gradational layer between the surface soil and the subsoil. The subsoil is red stiff brittle clay extending to a depth of 30 to 36 inches. Under normal moisture conditions this clay breaks into irregular-shaped lumps and is easily crushed to a friable mass. Below this is mottled light red, yellow, and gray friable clay containing a considerable quantity of small mica scales, and this clay, at a varying depth, rests on the disintegrated and partly decomposed granite or gneiss.

In wooded areas or in areas that have not been cultivated, the first inch or two of the surface soil contains enough organic matter to give it a dark-brown or grayish-brown color. Included with this soil, as mapped in the field, are a few small areas of the Appling and Durham soils. In places a few angular fragments of quartz are scattered over the surface and mixed with the surface soil. In some places sheet erosion has removed a part or all of the original surface soil, exposing the yellowish-red sandy clay or red clay. Such exposed areas are locally called galled spots.

Cecil sandy loam is an extensive and important soil and is well distributed over the north-central and western parts of the county. Some of the largest areas are north of Manson (extending to the North Carolina-Virginia State line), west of Oakville, in the vicinity of Norlina, and around Axtell. Smaller areas are scattered over the county, particularly south of Vicksboro, west of Liberia, near Panacea Springs, and south of Inez.

This soil occupies the high, broad interstream areas and the gradual slopes toward the streams. In general the relief ranges from almost level or undulating to gently sloping or gently rolling. All the land lies favorably for the use of both light and heavy farm machinery. It has good natural surface drainage in both the surface soil and the subsoil, and it warms early in the spring. It can be cultivated under a wide range of moisture conditions.

Cecil sandy loam is an important agricultural soil in Warren County, and practically all of it is or has been cultivated. Some of the areas once cultivated and abandoned are now grown up to old-field pine. The crops grown on this soil are cotton, corn, wheat, some tobacco, legumes, garden vegetables, and fruits for home use.

Cotton yields from ½ to 1 bale an acre when the land is fertilized with 200 to 500 pounds of a 3–8–3 or 4–8–4 mixture and a top dressing of 100 pounds of nitrate of soda. Corn yields from 10 to 25 bushels an acre, depending on the quantity of fertilizer applied and whether a leguminous crop has been turned under. Most of the farmers apply 100 to 200 pounds of a 3–8–3 or 4–8–4 mixture and from 50 to 100 pounds of nitrate of soda as a side application. Wheat yields from 10 to 18 bushels to the acre when the land receives 100 to 200 pounds of 16-percent superphosphate at the time of sowing and a top dressing of 100 pounds of nitrate of soda in the spring. Generally cornland and wheatland do not receive heavy fertilization, and this accounts for the normally low yields. Bright-leaf tobacco yields from 700 to 1,000 pounds an acre when 800 to 1,000 pounds of 3–8–3 or 3–8–5 fertilizer is used. The yields of tobacco on this soil are slightly higher than on the Durham and Appling soils, but the quality of the leaf is not quite so good. Cowpeas, soybeans, and some clover are grown. The yields of these depend on the quantity of fertilizer or manure that has been applied. Sweetpotatoes and peanuts do well when the land is fertilized. All kinds of garden vegetables suited to this climate grow successfully, and apples and peaches do well when the trees are sprayed and properly cared for.

Cecil sandy loam is very responsive to good management and can be built up to a rather high state of productivity. Like all the soils of Warren County, it is acid to strongly acid and would be benefited by an application of 1 to 2 tons of lime to the acre if it has not been limed within the last 3 years. Growing and turning under leguminous crops would supply the needed organic matter and greatly increase the yields of corn and wheat. An application of phosphatic fertilizer should be given the soil when clover and lespedeza are seeded. On some of the more sloping areas properly constructed terraces and a good system of crop rotation would be beneficial in controlling the run-off of rain water, and these measures with some strip crops or permanent grass would practically prevent further sheet erosion.

Cecil fine sandy loam.—Cecil fine sandy loam is well distributed over the northern half and the southwestern part of the county. The largest areas are along the Warren-Vance County line, Shocco Creek, north of Vaughan, southwest of Panacea Springs, and northwest of Littleton. Other areas occur north of the Roanoke River along the North Carolina-Virginia State line and elsewhere throughout the county.

Cecil fine sandy loam differs from Cecil sandy loam essentially in that the texture of the surface soil and subsoil is finer. The color of the surface soil and subsoil is similar to that of the corresponding layers of Cecil sandy loam. The relief ranges from undulating or gently sloping to gently rolling. Both surface and internal drainage are good, but this soil, owing to its finer texture, does not warm so early in the spring or dry out so quickly as does the sandy loam.

The crops grown, kind and quantity of fertilizer applied, cultural methods, and yields of the various crops are practically the same on the two soils. Recommendations for the improvement of the sandy loam apply to this soil.

Cecil fine sandy loam, eroded phase.—Cecil fine sandy loam, eroded phase, differs from Cecil fine sandy loam in that the surface soil is not uniformly fine sandy loam. As mapped in Warren County this soil includes areas of Cecil fine sandy loam and Cecil sandy loam that have lost from 30 to 60 percent of the original sandy covering through sheet erosion. The removal of the sandy surface soil is not uniform; each field presents a spotted appearance because it comprises small spots of sandy loam, red clay loam, and, in places, fine sandy loam, although the covering of fine sandy loam is thin.

This is one of the extensive and important soils in the county, and it is well distributed over all parts. Some of the largest areas are in the southeastern corner near and west of St. Paul Church, in the southwestern part east and west of Shocco School, north and south of Manson, in the northwestern part in the vicinity of Russell Union School, and in the northern part north and south of the Roanoke River.

Cecil fine sandy loam, eroded phase, occurs in close association with Cecil sandy loam and Cecil fine sandy loam, but the relief is generally more sloping and rolling than that of either of those soils. The eroded soil occurs on the broad interstream areas where the slope ranges from about 3 to 10 percent. Natural surface drainage is good, but internal drainage is fair to slow. Sheet erosion is active on all areas not protected by grass, other close-growing vegetation, or trees.

This is one of the important agricultural soils in the county, and it is used mainly for the production of cotton, tobacco, and corn. Fair yields of wheat and corn are obtained when the land is properly fertilized or manured. The quality of the tobacco grown on this eroded soil is not quite so good as that produced on Cecil sandy loam or Cecil fine sandy loam, owing to the inclusions of spots of red clay loam. Under the same cultural treatment and fertilization, the yields of cotton are almost as good as those obtained on the sandy loam, and the yields of wheat are slightly larger. Terracing, crop rotation, and strip farming are strongly recommended for this eroded soil. This soil could be improved considerably by turning under leguminous crops, by applying lime, and by deeper plowing. Lespedeza and clover can be grown successfully if the soil is properly prepared, fertilized, and limed. The more sandy areas are well suited to the growing of garden vegetables and peanuts.

Cecil very fine sandy loam.—This is an inextensive soil and occurs only in two areas, one south of Vaughan and one southwest of Old Bethlehem. It lies on the high, broad interstream areas, and the surface is almost level or undulating to gently sloping. Natural drainage is good, but the soil does not warm so early or dry out so quickly in the spring as the more sandy members of the Cecil series. This is due to the presence of more very fine material in the surface soil and to some extent in the subsoil.

In cultivated fields Cecil very fine sandy loam is grayish-yellow or yellowish-brown very fine sandy loam to a depth of 3 to 5 inches. Very fine sand and fine sand constitute more than 50 percent of the

surface soil. Between the surface soil and the subsoil is a 1- to 3-inch layer of yellowish-red very fine sandy clay. The subsoil, which reaches a depth of 36 to 40 inches or more, is red stiff but brittle clay or silty clay. Underlying this is light-red friable clay mottled with yellow. At a varying depth this material grades into disintegrated and partly decomposed fine-grained schist rock.

Probably two-thirds of this soil is under cultivation, mainly to cotton, corn, and wheat; and the yields are slightly less than those obtained on Cecil fine sandy loam. In some places part or all of the original surface soil has been removed through sheet erosion, exposing the red clay. Constructing proper terraces on the more sloping areas and seeding this soil to grasses or lespedeza are highly recommended. The soil can be built up to a fair state of productivity by growing and turning under leguminous crops, such as lespedeza and clover. When it has been improved and limed it will produce good yields of corn, wheat, and hay crops.

Cecil clay loam.—The surface soil of Cecil clay loam, locally called red clay land, is dark-brown or reddish-brown clay loam or heavy sandy clay loam, 6 to 8 inches thick. The subsoil is red heavy stiff but brittle clay, which extends to a depth of 30 to 36 inches. It is underlain by lighter red or reddish-yellow moderately friable clay containing a small quantity of coarse sand and mica scales. At varying depths this material grades into the light-gray or mingled light-gray, white, and light-red partly decomposed granite or gneiss. In forested areas the surface layer is brown sandy loam to a depth of 1 to 3 inches. In some of the cultivated fields, or even in some of the fields once cultivated and now grown up to old-field pine, the original surface soil has been removed, exposing the red heavy clay.

Included with this soil on the map are small areas south of Panacea Springs in which the surface soil is dark reddish brown and the subsoil is dark-red or maroon heavy smooth clay. This soil has developed from dark-colored basic rocks, and if the total area were larger it would be mapped as Davidson clay loam, one of the important soils in other parts of the Piedmont Plateau.

Cecil clay loam occurs in close association with the other Cecil soils and is well distributed over the county. Large areas are in the northeastern part, particularly northeast of Macon, along the Warren-Halifax County line, east of Fishing Creek, southeast and northeast of Coley Spring School, south of Manson, west of Olive Grove School, near Littleton, and west of Afton. In general, the relief of this soil is more sloping than that of the sandy loam, but it is not so rolling or so steep as that of Cecil clay loam, hilly phase. In most places the slope ranges from 3 to 8 percent, and much of this land lies favorably for cultivation. Surface drainage is good and in some places may be excessive, owing to the fact that the heavy-textured subsoil does not take up the rainfall readily, although the uniform red color of the subsoil indicates good drainage and aeration. In many places sheet erosion is quite active. In fact, most of this soil had a covering of sandy loam or fine sandy loam before it was cleared of its native vegetation. Sheet erosion has removed most of the sandy material, and cultivation has mixed some of the sandy surface soil with the red clay subsoil.

The principal crops grown are corn, cotton, small grains, and legumes. Cornland is fertilized with 100 to 200 pounds of a 3–8–3 or 4–8–4 mixture prior to the time of planting and is given a side dressing of 50 to 100 pounds of nitrate of soda as a top dressing when the plants are 16 to 20 inches in height. Yields of corn range from 8 to 25 bushels an acre. Larger yields of corn have been obtained on this soil where leguminous crops have been turned under. Land for cotton usually receives from 200 to 400 pounds an acre of a 3–8–3 or 4–8–4 mixture and from 75 to 100 pounds of nitrate of soda as a top dressing. Yields of cotton range from one-half to three-fourths of a bale an acre. Wheat yields from 10 to 20 or more bushels an acre when 200 pounds of superphosphate is used at the time of sowing and a top dressing of 100 to 150 pounds of nitrate of soda is applied in the early spring. Lespedeza does well on this soil, particularly if given a little start with commercial fertilizer and lime.

Inherently Cecil clay loam is a good strong soil, but it is low in content of organic matter. The soil, particularly the subsoil, has a high content of potash. This soil does not warm so quickly in the spring as the soils having sandy surface material. It requires heavy farm machinery and strong work animals for the most efficient handling under all conditions. If plowed under proper moisture conditions, a fairly good tilth can be obtained, especially where there is an appreciable quantity of sand in the surface soil. If plowed when too dry, however, the soil breaks into large clods that remain intact throughout the earlier period of cultivation and often for some time during the cropping season. If plowed when too wet, the soil hardens and is very difficult to manage. The incorporation of organic matter and barnyard manures and the addition of lime are recommended for the improvement of this soil. Under proper management it can be built up to a good state of productivity. It is subject to both sheet and gully erosion; and properly constructed terraces, together with strip farming and seeding of the more sloping areas with close-growing crops, would help retain the soil material and the soil moisture. Cowpeas, or preferably soybeans, lespedeza, and clover are grown to some extent to improve the soil, and, where these crops are turned under and the soil is limed at the rate of 1 to 2 tons an acre, materially increased yields are obtained.

Cecil clay loam, hilly phase.—Cecil clay loam, hilly phase, differs essentially from Cecil clay loam in that it has strongly sloping to hilly and broken relief. Another important difference is that sheet erosion, being more active on this soil, has exposed the clay subsoil in many places. This soil occurs mainly in close association with typical Cecil clay loam and with Cecil sandy loam. At one time this hilly soil had a sandy surface soil, but sheet erosion has removed most of it.

Cecil clay loam, hilly phase, is well distributed over the county. The largest areas are in the southwestern part, particularly along Fishing and Shocco Creeks. Other areas occur on the breaks leading to the first bottoms of many of the larger streams. Surface drainage is good to excessive, as the surface soil does not take up the rain water readily and a large proportion of it rushes off the hillsides, carrying with it considerable fine material. Internal drainage is

adequate, as the uniform color of the subsoil indicates. This movement, however, is slow.

Only a small part of Cecil clay loam, hilly phase, is cultivated. Most of this soil was cultivated at one time or another, but it became eroded and gullied and was abandoned. At present most of it is grown up to second-growth pine and some hardwoods. Some corn, small grains, clover, and lespedeza are produced. Yields of these crops are low unless the land is fertilized or the crops follow a fertilized leguminous crop that has been turned under. With clean cultivation this soil is subject to further sheet erosion and gullying. In its present condition forestry is the best use for this hilly soil. Lespedeza and clover do reasonably well, and with the use of fertilizer a fair yield of pasture grasses and hay crops may be obtained. The growth of these crops would improve the soil and largely prevent sheet erosion.

Appling sandy loam.—Appling sandy loam is one of the extensive and important soils of the county. This soil, together with Appling fine sandy loam and Appling very fine sandy loam, in color of the subsoil is intermediate between the red of the Cecil and the yellow of the Durham. In structure, consistence, and drainage, there is very little difference between this soil and Cecil sandy loam.

Appling sandy loam has a grayish-yellow or light-gray sandy loam surface soil to a depth of 4 or 5 inches in cultivated areas. This grades into pale-yellow sandy loam, which extends to a depth of about 8 or 10 inches. The upper 2- or 3-inch layer of the subsoil is yellow or faintly reddish yellow sandy clay. This material grades into yellowish-brown or reddish-yellow stiff but brittle clay, which continues downward to a depth of about 2 feet. Below this the material is mottled light-red, yellow, and almost white friable clay containing a few small mica scales. At a depth of 30 to 40 inches or more this is underlain by the disintegrated and partly decomposed granite rock. In wooded areas the topmost 1 or 2 inches of the surface soil is gray or grayish brown, owing to the presence of a small quantity of organic matter. In a few places the subsoil is brown, heavy, somewhat plastic clay. In mapping it was necessary to include some very small areas of Durham and Cecil sandy loams.

Appling sandy loam is well distributed over all parts of the county. Some of the largest areas occur in the vicinity of Norlina and extend northward to the North Carolina-Virginia State line, in the vicinity of Macon, north and east of Warren Plains, north of Warrenton; and in the vicinity of Inez, Afton, and Vicksboro. Other areas are along the Warren-Halifax County line north of Littleton.

The relief is undulating, gently sloping, or gently rolling with a general slope toward the natural drainageways. Most of this soil occupies broad interstream areas and lies favorably for farming operations. Surface and internal drainage are good. On the more sloping areas sheet and gully erosion are noticeable, and in some places a large part of the original sandy surface soil has been removed.

Appling sandy loam is one of the important agricultural soils, and a large proportion of it is under cultivation. The principal crops are cotton, corn, tobacco, some small grains, and legumes. Cotton yields from one-half to three-fourths of a bale an acre when 300 to 400 pounds of a 3–8–3 or 4–8–4 fertilizer is applied, usually with 75

to 100 pounds of nitrate of soda used as a top dressing. Corn yields from 10 to 20 bushels an acre, and the land is usually fertilized with 100 or 150 pounds to the acre of a 3–8–3 or 4–8–4 mixture and given a side dressing of 50 pounds of nitrate of soda. Bright-leaf tobacco yields from 700 to 900 pounds an acre, and the land is fertilized with 800 to 1,000 pounds to the acre of a 3–8–3, 3–8–5, or, in some instances, 3–8–6 mixture. Most of the farmers use the available barnyard manure on the land for wheat and top-dress the wheat in the spring with 100 to 150 pounds of nitrate of soda to the acre. The yields range from 8 to 15 bushels an acre. When superphosphate is applied at the time of sowing, yields of wheat are sometimes higher than those given above. Sweetpotatoes, peanuts, and garden vegetables do well on this soil when it is properly fertilized or manured.

This soil ranks next to Durham sandy loam and Durham fine sandy loam for the production of a fine quality of bright-leaf tobacco. It is easily tilled, warms early in the spring, and can be cultivated under a wide range of moisture conditions. It is very responsive to good management. Sheet erosion is doing considerable damage to this soil on the more sloping areas, and in a few places shallow gullies have formed. Properly constructed terraces, together with rotations, strip crops, or the seeding of the more sloping areas to grasses, clover, and lespedeza would, in a large measure, control erosion on this soil. The yields of corn and wheat could be considerably increased if the organic-matter content of the soil were higher and if a more liberal application of fertilizer were given to land for these crops. The application of 1 to 2 tons of lime an acre, or barnyard manure, and the growing and turning under of leguminous crops and including leguminous crops in the rotation would greatly increase the yields of corn, small grains, and hay crops. The soil can be built up to a fair or high state of productivity.

Appling sandy loam, slope phase.—Appling sandy loam, slope phase, occurs in several small areas in close association with Appling sandy loam and Appling fine sandy loam. It differs mainly from these soils in that it has a sloping to rolling relief, as it generally occupies the breaks leading from these soils to the first-bottom soils. The slope ranges from about 10 to 25 percent. Both surface and internal drainage are good. Sheet erosion is noticeable on areas that have been in clean cultivation, and it is much more severe than on the typical sandy loam, which has a smoother surface. In some places practically all of the original surface soil has been removed through sheet erosion, especially on those areas that have been under cultivation for a long time. On some of the smoother areas a good covering of sandy surface soil remains; and if proper terracing and strip farming were practiced, the soil could be held without much loss from erosion.

Included with Appling sandy loam, slope phase, are several small areas of Appling fine sandy loam, slope phase. These occur in association with Appling fine sandy loam. The relief, drainage, and erosion conditions on the included soil are similar to those features of Appling sandy loam, slope phase. Practically the only difference between these two soils is in the texture of the surface soil.

Only a small part of Appling sandy loam, slope phase, is under cultivation. The crops grown, cultural methods, and quantity and

kind of fertilizer applied are about the same as for Appling sandy loam or Appling fine sandy loam, but yields are slightly less. This may be due in part to a less favorable moisture condition and also to the fact that the soil, having a sloping surface, is not so easily managed as one having a smoother surface. The steeper areas and also those that have lost the surface soil through erosion should be used for forestry or seeded to grasses for pasture.

Appling sandy loam, gravelly phase.—Appling sandy loam, gravelly phase, is similar in color, texture, and structure of the surface soil and subsoil to Appling sandy loam. Angular fragments of quartz, ranging from 1 to 5 inches in diameter, are scattered over the surface and form from 15 to 40 percent of the soil mass. In addition there are a few angular fragments of granite. The gravel in most places does not interfere seriously with cultivation, but where it is most abundant it has a decided wearing effect on farm implements. On the other hand, the gravel on the surface tends in some measure to prevent sheet erosion, and it is reported that the gravel once warmed keeps the soil warmer than it would be if no gravel were present.

The total area of Appling sandy loam, gravelly phase, is small. The largest body is south of Inez in the vicinity of Mayflower School. Smaller areas are north of Bakers School, north of Littleton, and southeast of Lovely Hill Church. Most of this gravelly soil has gently sloping to rolling relief, and both surface and internal drainage are good.

A large part of this soil is used for the production of cotton and corn, although some tobacco, small grains, and clover are grown. The kind and quantity of fertilizer applied, methods of cultivation, and yields of the various crops generally are similar to those on Appling sandy loam, although in some places yields are slightly less. The recommendations suggested for improvement of typical Appling sandy loam apply to the gravelly soil.

Appling fine sandy loam.—Appling fine sandy loam is an extensive and important soil, well distributed over the county. Some of the largest areas occur in the northwestern corner around Mount Auburn Church, on the western border near New Hope Church and Manson, northeast of Stony Lawn School, in the vicinity of Liberia, Embro, Vaughan, and Littleton, and along the main highway between Littleton and Macon. Smaller areas are south of Grove Hill, southeast of Hicks School, west of Bakers School, and in the vicinity of Olive Grove School.

Appling fine sandy loam differs from Appling sandy loam mainly in that both the surface soil and the subsoil have a higher content of fine material. In some ways fine material gives this soil an advantage over the sandy loam; on the other hand it may have a slight disadvantage in that the soil does not warm so quickly as the coarser textured soil. Included with this soil on the map are a few small areas of Durham fine sandy loam and Cecil fine sandy loam. The land ranges from smooth or undulating to gently sloping or gently rolling. Both surface and internal drainage are good. In places sheet erosion has removed part or all of the original surface soil and the fine sandy clay subsoil lies near the surface or is exposed.

The same kind of crops are grown and the same fertilizer applications and methods of cultivation are used as on Appling sandy loam. Under similar treatment the yields on the two soils are almost the same. This soil is deficient in organic matter, which can be supplied in a large measure by turning under leguminous crops. The recommendations for the improvement of this soil and protection from sheet erosion on the more sloping areas are the same as those made for similar areas of Appling sandy loam.

Appling very fine sandy loam.—This soil occurs in several fair-sized areas in the southeastern part of the county in close association with the Cecil soils. Some of the largest areas lie northeast of Embro, at Old Bethlehem, and in the vicinity of Long School, Arcola, and Grove Hill. It occurs on the broad interstream areas, and the relief is undulating to gently sloping or gently rolling. Natural surface drainage is good, but internal drainage is slow though fairly good.

In cultivated fields Appling very fine sandy loam is light-gray or grayish-yellow very fine sandy loam, underlain at a depth of 3 to 6 inches by a subsurface layer, a few inches thick, of pale-yellow very fine sandy loam. The first 2- or 3-inch layer of the subsoil is brownish-yellow or reddish-yellow very fine sandy clay, and this grades into yellowish-red or yellowish-brown rather stiff brittle clay, which extends downward to a depth of about 2 feet. Below this is mottled light-red and yellow friable clay. This material is only a few inches thick and grades into the partly decomposed fine-grained schist. In some places the surface soil contains a larger proportion of silt than is typical, and this gives it a somewhat floury feel. In a few places the subsoil is near the surface, and in some places the texture is almost silty clay.

This soil is well suited to the production of corn, cotton, lespedeza, and soybeans; but it is not so well suited to the production of cotton as the lighter textured soils. It does not drain so readily or warm so quickly in the spring as Appling sandy loam or Appling fine sandy loam. Under the same cultural methods and fertilizer applications, yields are usually slightly less than those obtained on the other Appling soils, unless this soil has been well supplied with organic matter. The recommendations for the improvement of this soil are the same as those for Appling sandy loam.

Durham sandy loam.—In cultivated fields Durham sandy loam is grayish-yellow, very light gray, or almost white light-textured sandy loam to a depth of 4 to 6 inches. It is underlain to a depth of 10 to 14 inches by pale-yellow or grayish-yellow friable sandy loam. The subsoil consists of moderately stiff but brittle clay or heavy friable sandy clay to a depth of 25 to 35 inches. Beneath this is light-gray, red, and yellow sandy clay material. At varying depths this grades into the soft disintegrated granite rock from which the soil material is developed. Included with this soil are small areas having a yellow, heavy, rather tough clay subsoil that contains some gray or reddish-brown mottles in the lower part. There are also a few areas at the base of the slope that are not so well drained as the typical soil, and the surface soil is yellow clay mottled with yellow and gray below a depth of 20 inches. This inclusion would be mapped as Colfax soil if it were more extensive.

Durham sandy loam occurs in close association with Appling sandy loam. It is one of the extensive and important soil types in the county. It is the predominant soil in the vicinity of Warren Plains and Warrenton and north of Wise, where it occurs in two large unbroken areas. Smaller areas are in other parts of the county, near Norlina, Paschall, and Pleasant Hill Church; west of Afton; and south of Inez.

Most of this soil occupies the broad, flat interstream areas, where the surface is almost level, undulating, or gently sloping to very gently rolling. Both surface and internal drainage are good. This soil lies favorably for agricultural use. Sheet erosion is active on the more sloping areas. Properly constructed terraces will aid in controlling the run-off of rain water and, in a certain measure, check erosion on this soil. It may be necessary to strip crop here and there on the more sloping areas.

A large part of this soil is under cultivation, and the principal crops are tobacco, corn, and cotton. It is one of the best soils for the production of bright-leaf tobacco in the Piedmont Plateau of North Carolina. Tobacco yields from 700 to 900 pounds an acre, and the land usually receives about 1,000 pounds of a 3–8–5 or 3–8–6 fertilizer to the acre. Some of the farmers apply a top dressing of about 100 pounds of 1–0–4 fertilizer when the plants are from 12 to 15 inches high, and also a few side dressings of 50 to 100 pounds of nitrate of soda. Cotton yields from one-half to three-fourths of a bale to the acre when the land is fertilized with 200 to 400 pounds of a 3–8–3 or 4–8–4 mixture. Cornland is usually given 150 to 200 pounds an acre of a similar mixture, and yields range from 10 to 20 bushels an acre. A top dressing of 50 to 100 pounds an acre of nitrate of soda is generally applied for both cotton and corn. Some rye, sweetpotatoes, and garden vegetables are successfully grown on this soil. These crops do remarkably well when the soil is manured or heavily fertilized. It is reported that Durham sandy loam and Durham fine sandy loam produce probably 75 percent of all the tobacco grown in this county.

Durham sandy loam is very low in organic matter. This constituent is not required in the production of a high quality of tobacco, as the nitrogen and other constituents can be supplied through the application of the proper quantity and kind of fertilizer. Organic matter is very essential to this soil, however, especially in the production of corn and cotton. Liming and the growing and turning under of leguminous crops are recommended for improvement of the soil.

Durham fine sandy loam.—Durham fine sandy loam is an inextensive soil closely associated with Appling fine sandy loam and Durham sandy loam. Some of the largest areas are west of Littleton, southeast of Inez Church, north of Afton, in the vicinity of Manson and Embro, west of Youngs School, south of Elams, north of Vaughan, and at Elberon.

This soil differs from Durham sandy loam chiefly in having a finer textured surface soil and subsoil. It includes a few small areas of Durham very fine sandy loam. The land is almost level, undulating, or very gently sloping. Both surface and internal drainage are good.

This is an excellent soil for the production of bright-leaf tobacco. Some cotton and corn are grown. Yields of these crops are comparable with those obtained on Durham sandy loam under the same cultural treatment and fertilization. Like Durham sandy loam, this soil is very deficient in organic matter. On the more sloping areas sheet erosion is noticeable, but it can be checked in large measure by rotations including close-growing crops and legumes or by terraces together with strip farming. In some places erosion can be checked by contour cultivation. For the production of corn and other crops, the incorporation of organic matter in this soil is important. The soil is well suited to the growing of peanuts and garden vegetables.

Helena fine sandy loam.—In cultivated fields Helena fine sandy loam is grayish-yellow fine sandy loam to a depth of 4 to 6 inches. This is underlain by pale-yellow, grayish-yellow, or, in some places, brownish-yellow fine sandy loam, which extends to a depth of 12 to 14 inches. The subsoil is mottled light-gray, yellow, or brownish-yellow heavy tough or plastic clay. This grades at a depth of about 30 inches into light-gray silty clay containing brownish-yellow mottles. In places the subsoil is yellowish-brown heavy plastic clay having the characteristics of the Iredell subsoils. In a few other places, particularly where this soil borders the Appling or Cecil soils, the subsoil is yellowish-brown heavy tough clay. Included with this soil are small areas in which the surface soil is very fine sandy loam, sandy loam, or almost coarse sandy loam.

The largest areas are in the eastern and southeastern parts of the county, southeast of Vaughan, and north of Inez. A fair-sized area is in the extreme northeastern corner bordering the North Carolina-Virginia State line. Other bodies are north of Wise, east of Elams, near Grove Hill, west of Jerusalem Church, and east of Lickskillet. This soil is closely associated with the Wilkes and Appling soils and, to less extent, with the Cecil.

Most of this soil lies on the interstream ridges, but some of it occupies the slopes leading to the first bottoms. The land ranges from almost level or undulating to gently rolling or rolling. Surface drainage is good, but, because of the heavy texture of the subsoil, internal drainage is slow. The thick layer of fine sandy loam over the heavy subsoil insures fair drainage for the growing of shallow-rooted crops.

Most of the land is under cultivation. Tobacco and corn are the principal crops, and some cotton, small grains, and clover are grown. Yields of tobacco range from about 600 to 800 pounds an acre when 3–8–3 or 3–8–5 fertilizer is applied at the rate of 800 to 1,000 pounds to the acre. Corn yields from 8 to 15 bushels when the land is fertilized with 100 to 200 pounds of a 3–8–3 or 4–8–4 mixture. Some of the farmers apply 100 pounds of nitrate of soda to the acre as a top dressing when the corn is about 16 to 20 inches high. Cotton yields from one-third to two-thirds of a bale to the acre, and the land for cotton usually receives a 3–8–3 or 4–8–4 mixture at the rate of 200 to 400 pounds to the acre.

As its color indicates, this soil is deficient in organic matter. This material can be supplied by growing and turning under leguminous crops. In many places sheet erosion is noticeable, and this should be checked in order to hold the sandy surface soil. If the sandy cover-

ing is removed and the heavy tough clay is exposed, this soil will not be suitable for the growth of tobacco and corn. Terracing, together with strip farming, will control the run-off of the rain water and hold most of the soil.

Wilkes sandy loam.—Wilkes sandy loam occurs in many scattered areas throughout the county. Some of the largest are at the headwaters of Dicks Branch in the northwestern corner of the county, east of Sandy Creek, southwest of Inez, west of Liberia and Afton, northwest of Grove Hill, south of Vaughan, northwest of Littleton, and south of Elams. It occupies the slopes between the smoother uplands and the first bottoms. The relief is variable. It is dominantly rolling to hilly and broken. Surface drainage is good, but internal drainage is slow, owing either to the presence of heavy material in the subsoil or to the fact that bedrock lies near the surface. This is the most eroded soil in the county. Both sheet and gully erosion are severe in many places.

There is practically no uniformity in the surface soil or in the subsoil, and this soil represents a condition rather than a well-developed soil. It comprises small areas of the Helena, Cecil, Appling, and Durham soils and transitions between these soils. In a few places the surface soil is yellowish-gray sandy loam to a depth of 4 to 6 inches, and the subsoil is pale-yellow or grayish-yellow sandy clay a few inches thick. This material is underlain by mottled yellow clay and brown plastic clay. In places this soil consists of only a thin layer of sandy loam, which grades into the soft disintegrated granite rock cut by dikes of dark basic rock.

A small proportion of this soil is used for the production of corn and tobacco. Areas with the deeper sandy surface soil are used for the growing of tobacco, and a fair quality is obtained. Yields are around 700 or 800 pounds an acre when 3–8–3 or 3–8–5 fertilizer has been applied at the rate of about 1,000 pounds to the acre. Cornland receives only a small quantity of complete fertilizer and in some instances a side dressing of nitrate of soda. Yields are usually low. This soil is deficient in organic matter. The best uses for most of the land are forestry and pasturage. The soil will continue to erode seriously if clean cultivation is practiced. Some of the areas formerly cultivated have been destroyed for general farming purposes because of both sheet and gully erosion.

Worsham sandy loam.—Worsham sandy loam, a very inextensive and unimportant soil, occupies very small poorly drained areas in the uplands in close association with the Durham, Appling, and Helena soils. One of the largest bodies occurs along the highway between Macon and Norlina. Many areas are too small to show on a map of the scale used and are included with other soils in mapping.

Worsham sandy loam is variable in color and texture, but in most places it has a dark-gray or gray sandy loam surface soil from 6 to 8 inches thick. The subsoil is light-gray heavy sandy loam mottled with brown and extends to a depth of about 24 inches. Below this is mottled light-gray, brown, and yellow rather stiff heavy fine sandy clay or clay that is slightly sticky when wet. In places some of the more nearly white material in the lower part of the subsoil is used locally as whitewash.

Most of this soil occurs in slight depressions in the uplands or at the base of slopes and around streamheads. The surface is almost level to gently sloping. Drainage is poor, as the soil receives seepage water from the higher lying areas. None of this soil has been drained and reclaimed for general-farming purposes. The best use for it is as summer pasture. If the soil were drained, limed, and fertilized, corn, oats, and pasture grasses would grow.

Altavista fine sandy loam.—Altavista fine sandy loam occurs in small areas on the second bottoms or low terraces along the Roanoke River and Fishing, Shocco, and Reedy Creeks. It lies above normal overflow of the streams. The surface is almost level to undulating. Surface and internal drainage are imperfect, and small lateral ditches to carry off the excess rain water are beneficial.

The surface soil to a depth of 2 to 6 inches is gray, brownish-gray, or grayish-yellow fine sandy loam. It is underlain by pale-yellow heavy fine sandy loam that is only a few inches thick. The subsoil of yellow heavy fine sandy clay or friable clay at a depth of about 2 feet grades into yellow fine sandy clay containing some gray or reddish-brown mottles. Included with this soil are small areas of very fine sandy loam, and in some places the subsoil is distinctly mottled with gray and brownish yellow.

Only a small proportion of the land is cultivated. Corn, the principal crop, returns low yields, except in a few places where a liberal quantity of fertilizer has been applied. This soil is strongly acid and is deficient in organic matter; therefore the addition of lime and the turning under of green-manure crops are highly recommended. Much of this soil would be benefited by artificial drainage. It the soil were drained and limed and organic matter were added, it would produce fair yields of corn, oats, and pasture grasses.

Congaree silt loam.—Congaree silt loam is brown mellow friable silt loam to a depth of 8 to 12 inches. It is underlain by yellowish-brown or light-brown fine sandy loam or fine sandy clay loam, to a depth of 30 inches or more. Small scales of mica are present in the surface soil and subsoil. Generally below a depth of 30 inches the subsoil consists of mottled light-gray and rust-brown fine sandy loam or loamy fine sand.

This is an inextensive soil of the first bottoms, although some rather long areas border Fishing, Little Fishing, Shocco, Little Shocco, and Reedy Creeks. There are a few bodies along the Roanoke River. The surface ranges from almost level to undulating. Both surface and internal drainage are good for a soil in a low first-bottom position.

Congaree silt loam is fertile, but, as it is subject to frequent overflows, only a small proportion of it is cultivated. Corn, the main crop, yields from 30 to 40 bushels an acre, even in places where little or no commercial fertilizer is used. The main use for this soil is as summer pasture for cattle. Some areas support a rather thick growth of alders, willows, and other water-loving trees. If this soil could be protected from overflow, limed, and fertilized, large yields of corn and hay could be obtained. After the application of phosphatic fertilizer, pasture grasses would do exceptionally well.

Congaree silty clay loam.—Congaree silty clay loam occurs in small areas in the northern part of the county in the first bottoms of the Roanoke River. It differs from Congaree silt loam essentially in

that it is heavier in texture. The materials forming this soil were laid down in very quiet water during times of overflow. The surface is prevailingly level or slightly undulating, and natural surface drainage is fair. The land is subject to heavy overflow.

The surface soil consists of brown or reddish-brown silty clay loam or silty clay, uniform in color and texture, and continuing to a depth of 30 inches or more. In some places it extends to an even greater depth, but generally below a depth of 30 inches it becomes mottled light-gray, brown, or yellow silty clay. Some of the recent overflows have deposited a 1- to 3-inch layer of gray silt loam in a few places.

Inherently Congaree silty clay loam is a fertile soil. A large part of it is planted to corn, and in favorable seasons and when the crop is not damaged by overflow the yields range from 25 to 35 bushels an acre without the use of fertilizer. If this soil were fertilized it could be made to produce from 40 to 60 bushels. The less well-drained areas are well suited to the production of pasture grasses.

Congaree fine sand.—Congaree fine sand is one of the inextensive and unimportant soils in the county. It occurs in a continuous narrow strip along the south side of the Roanoke River and to a less extent on the north side. It occupies a leveelike position slightly higher than the other first-bottom soils. The surface is almost level, undulating, or gently sloping. The soil is naturally well drained and is not overflowed so frequently as the associated soils in the first bottoms.

Congaree fine sand is grayish-brown or brownish-yellow fine sand to a depth of 3 feet or more. The material contains a few small flakes of mica. In places the texture is loamy fine sand, especially in places where it grades into Congaree fine sandy loam.

Only a very small proportion of the land is cultivated, and this is used mainly for corn, which returns low yields. This soil is best suited to the growing of watermelons, peanuts, and early-season crops. Rye does fairly well. For any crop grown the land should be given a heavy application of fertilizer or barnyard manure.

Wehadkee silt loam.—The largest area of this soil lies on the south side of the Roanoke River between Hubquarter and Stonehouse Creeks. A smaller area is at the confluence of Big Stonehouse Creek and Little Stonehouse Creek. It occurs in the first bottoms and is subject to frequent overflow. The surface is almost level, but there are a few swales or slight depressions. Both surface and internal drainage are poor. Some of this soil, particularly in the slight depressions, is in a semiswampy condition part of the year.

Wehadke silt loam is dark-gray or grayish-brown silt loam to a depth of 5 to 8 inches. The subsoil is mottled light-gray, yellow, and rust-brown silty clay loam or silty clay extending to a depth of 36 inches or more. In some places the subsoil is slightly compact silty clay; in others it is bluish-gray slightly plastic clay.

Part of the land supports a growth of tuliptree, black tupelo or black gum, sweetgum, water oak, ash, elm, and shortleaf pine. Some of this soil is used for pasture, but none of it is under cultivation. If drained, reclaimed, and limed, it would produce good yields of corn, oats, and pasture grasses. Pastures would be greatly improved by the application of phosphatic fertilizer and by the seeding of a

proper mixture of grasses. Under present conditions this soil is best suited for pasture and forestry.

Wehadkee fine sandy loam.—Wehadkee fine sandy loam occurs in only one area—southwest of Eatons Ferry on the first bottoms along the Roanoke River. The surface is almost level to gently undulating. The soil is subject to heavy overflow. Both surface and internal drainage are poor.

Wehadkee fine sandy loam ranges from light-gray to dark-gray fine sandy loam to a depth of 6 to 8 inches. The subsoil is mottled light-gray, yellow, and brown fine sandy clay extending to a depth of 24 to 30 inches. This grades into light-gray fine sand. In some places the subsoil is loamy fine sand. In a few places the first 2 or 3 inches of the soil is brown, owing to the recent deposition of material washed from the red soils of the uplands. Most of this soil is in pasture, and under present conditions this appears to be the best use for it. Pasture grasses would be benefited by an application of lime and phosphatic fertilizer.

Alluvial soils (Congaree soil material).—Alluvial soils (Congaree soil material) includes mixed soil materials in the first bottoms that are so variable in texture, color, and structure that they cannot be separated into definite types of the Congaree series. The material is mainly of alluvial origin and has been washed from the soils of the uplands, brought down by the streams, and deposited on the first bottoms. In some places some areas of colluvial wash are included with the alluvial material. The texture is sand, fine sand, fine sandy loam, or silt loam. Small fragments of mica are conspicuous throughout.

This land type occurs in narrow and, in many places, very long strips in the first bottoms along practically all of the streams except the Roanoke River. In many places the surface of the land is only a foot or two above the normal water level of the streams, and all areas are subject to frequent overflow and to the addition of new material at each heavy rainfall. The land is almost level or slopes very gently in the direction of stream flow. Much of it is saturated during the greater part of the year. In some places the original soils of the first bottoms, which constituted some of the best soils in the county for the production of corn and hay, have been covered by recent deposits of sandy material. These sandy materials have filled the original stream channels, causing the streams to overflow their banks frequently.

Alluvial soils (Congaree soil material) are not cultivated except in small areas here and there. The spots of silt loam and fine sandy loam are naturally fertile, and if they were drained and reclaimed they would produce large yields of corn, hay, and sorgo. Under present conditions, however, the best use for this land is summer pasturage for cattle. Many areas could be reclaimed for good pasture by cutting off the brush and constructing a few small ditches.

PRODUCTIVITY RATINGS

In table 4 the soil series of Warren County are listed alphabetically, and estimated average acre yields of tobacco, cotton, corn, and wheat are given for each soil under the prevailing practices of management.

The amounts and kinds of fertilizer used are indicated in footnote 1 of the table.

TABLE 4.—*Estimated average acre yields of the important crops on each soil in Warren County, N. C., under prevailing practices*[1]

Soil	Tobacco	Cotton (lint)	Corn	Wheat
	Pounds	*Pounds*	*Bushels*	*Bushels*
Alluvial soils (Congaree soil material)				
Altavista fine sandy loam			10	
Appling sandy loam	[2] 800	300	12	10
Appling sandy loam, gravelly phase	800	300	12	10
Appling sandy loam, slope phase	700	250	10	9
Appling fine sandy loam	800	300	12	10
Appling very fine sandy loam	750	275	10	9
Cecil sandy loam	850	325	15	12
Cecil fine sandy loam	850	325	15	12
Cecil fine sandy loam, eroded phase	750	275	10	13
Cecil very fine sandy loam		300	12	10
Cecil clay loam		275	12	13
Cecil clay loam, hilly phase				
Congaree fine sand			8	
Congaree silt loam			35	
Congaree silty clay loam			30	
Durham sandy loam	[2] 800	275	12	9
Durham fine sandy loam	[2] 800	275	12	9
Helena fine sandy loam	700	250	10	8
Wehadkee fine sandy loam				
Wehadkee silt loam			10	
Wilkes sandy loam	700	200	10	8
Worsham sandy loam				

[1] The prevailing practices of fertilization under which the estimated yields are obtained include:
Tobacco—800 to 1,000 pounds of complete fertilizer to the acre.
Cotton—200 to 400 pounds of complete fertilizer with 75 to 100 pounds of nitrate of soda added as a top dressing.
Corn—100 pounds of complete fertilizer with 50 to 100 pounds of nitrate of soda added as a side application.
Wheat—100 pounds of superphosphate, with 100 to 150 pounds of nitrate of soda added as a top dressing in the spring.

[2] The quality of the tobacco grown on these soils is superior to that grown on the other soils of the county. As a result, most of the tobacco acreage is on these soils.

The estimates in table 4 are based primarily on interviews with farmers, the county agricultural agent, members of the staffs of the North Carolina Agricultural Experiment Station and of the North Carolina State College of Agriculture and Engineering, and other persons who have had experience in the agriculture of this county. They are presented only as estimates of the average production over a period of years according to prevailing types of management. It is realized that these estimates may not apply directly to specific tracts of land for any particular year, since the soils as shown on the map vary somewhat, management practices differ slightly, and climatic conditions fluctuate from year to year. On the other hand, the estimates appear to be as accurate information as can be obtained without further detailed and lengthy investigations, and they serve to bring out the relative productivity of the soils shown on the map.

In order to compare directly the yields obtained in Warren County with those obtained in other parts of the country, yield figures have been converted in table 5 to indexes based on standard yields. The soils are listed in the approximate order of their general productivity under prevailing farming practices, beginning with the most productive.

TABLE 5.—*Productivity ratings of the soils of Warren County, N. C.*

Soil [1]	Crop productivity index [2] for—				General productivity grade [3]	General statement
	Tobacco (100=1,000 lbs.)	Cotton (100=400 lbs.)	Corn (100=50 bu.)	Wheat (100=25 bu.)		
Cecil sandy loam	85	80	30	48	4	The weighted averages of the indexes range from 50 to 70. Although shown here as only moderately productive, under more intensive management practices these soils become highly productive, especially for tobacco and cotton. The Durham soils are highly desirable for the growing of tobacco of good quality.
Cecil fine sandy loam	85	80	30	48	4	
Appling sandy loam	80	75	25	40	4	
Appling sandy loam, gravelly phase	80	75	25	40	4	
Appling fine sandy loam	80	75	25	40	4	
Durham sandy loam	80	68	25	35	4	
Durham fine sandy loam	80	68	25	35	4	
Cecil fine sandy loam, eroded phase	75	68	20	52	5	
Appling very fine sandy loam	75	68	20	35	5	
Appling sandy loam, slope phase	70	62	20	35	5	
Helena fine sandy loam	70	62	20	32	5	
Wilkes sandy loam	70	50	20	32	6	The weighted averages range from 30 to 50. In general, cotton is better adapted than tobacco.
Cecil very fine sandy loam	------	75	25	40	6	
Cecil clay loam	------	68	25	52	7	
Congaree silt loam [4]	------	------	40	------	8	If protected from overflow and artificially drained, some of these soils become very highly productive for corn. The weighted averages of the indexes range from 10 to 30.
Congaree silty clay loam	------	------	40	------	8	
Altavista fine sandy loam [4]	------	------	20	------	9	
Wehadkee silt loam [5]	------	------	20	------	9	
Congaree fine sand [4]	------	------	15	------	9	
Wehadkee fine sandy loam [5]	------	------	------	------	10	Without special measures of reclamation, cultivated crops are not adapted.
Alluvial soils (Congaree soil material) [4]	------	------	------	------	10	
Worsham sandy loam	------	------	------	------	10	
Cecil clay loam, hilly phase	------	------	------	------	10	

[1] Soil types, phases, and complexes are arranged in the descending order of their general productivity for the common crops under prevailing practices. (See footnote 1, table 4.)

[2] The soils are given indexes that indicate the estimated average production of each crop on each soil as a percentage of the standard; the standard has an index of 100 and represents the approximate average yield obtained without the use of amendments on the more extensive and better soil types of the regions of the United States in which the crop is most widely grown.

[3] The grade number indicates the general productivity of the soils and was determined by a weighted average of the productivity indexes for the crops as follows: Tobacco, 40; cotton, 30; corn, 25; and wheat, 5. The weighting was modified for soils on which one or more of the crops is not commonly grown. When the weighted average is between 90 and 100, a grade of 1 is given; when it is between 80 and 90, a grade of 2 is given, and so on.

[4] Only a small part of these soils is cultivated.

[5] If drained, comparatively high yields of corn, oats, and pasture would be obtained.

The rating compares the productivity of each of the soils for each crop to a standard of 100. This standard index represents the approximate average acre yield obtained without the use of amendments on the more extensive and better soil types of the regions of the United States in which the crop is most widely grown. An index of 50 indicates that the soil is about half as productive for the specified crop as is the soil with the standard index. The standard yield for each crop shown in table 5 is given at the head of each respective column. Soils given treatments, such as lime and commercial fertilizers, or special practices, such as irrigation or drainage, and unusually productive soils of small extent, may have productivity indexes of more than 100 for some crops.

The principal factors affecting the productivity of land are climate, soil (including the many physical, chemical, and biological character-

istics), slope, drainage, and management (including treatments). No one of these factors operates separately from the others, although some one may dominate. In fact, the factors listed may be grouped simply as the soil factor and the management factor, as slope, drainage, and most of the aspects of climate may be considered characteristics of a given soil type, for the soil type, as such, occupies specific geographical areas characterized by a given range of slope and climatic conditions. Crop yields over a long period of years furnish the best available summation of the associated factors and therefore are used where available.

General productivity grade numbers are assigned in the column "General productivity grade." The general productivity grade is based on a weighted average of the indexes for the various crops, as outlined in footnote 3 of table 5, the weighting depending on the relative acreage and value of the crops. As it is difficult to measure mathematically either the exact significance of a crop in the agriculture of an area or the importance or suitability of certain soils for particular crops, perhaps too much significance may be given to the order in which the soils are listed. It may be of interest to note that the indexes for tobacco and cotton are much higher than those for corn and wheat. If the general productivity grade had been based only on these two crops, some of the soils would have been placed in grade 2.

Productivity tables do not present the relative roles that soil types, because of their extent and the pattern of their distribution, play in the agriculture of the county. The tables show the relative productivity of individual soils. They cannot picture in a given county the total quantitative production of crops by soil areas without the additional knowledge of the acreage of the individual soil types devoted to each of the specified crops.

Economic considerations play no part in determining the crop productivity indexes. These indexes cannot be interpreted, therefore, into land values except in a very general way. Distance to market, relative prices of farm products, and other factors influence the value of land. It is important to realize that productivity, as measured by yields, is not the only consideration that determines the relative worth of a soil for growing crops. The ease or difficulty of tillage and the ease or difficulty with which productivity is maintained are examples of considerations other than productivity that influence the general desirability of a soil for agricultural use. In turn, steepness of slope, presence or absence of stone, the resistance to tillage offered by the soil because of its consistence or structure, and the size and shape of areas are characteristics of soils that influence the relative ease with which they can be tilled. Likewise, inherent fertility and susceptibility to erosion are characteristics that influence the ease of maintaining soil productivity at a given level. Productivity, as measured by yields, is influenced in some degree by all these and other factors, such as the moisture-holding capacity of the soil and its permeability to roots and water; therefore these factors should not be considered entirely separately from productivity. On the other hand, schemes of land classification to designate the relative suitabil-

ity of land for agricultural use must give some separate recognition to them.

LAND USES AND AGRICULTURAL METHODS[4]

The capabilities of the soils of Warren County have never been fully realized or appreciated by many farmers and landowners. Most of the soils are capable of being built up to a fair or even high state of productivity, and productivity can be maintained easily through proper treatment including a rotation of leguminous crops and an application of lime and phosphate. In any well-planned farm program the proper use of the soil is of fundamental importance in the building of a prosperous and permanent agriculture. The uses of the land inevitably change, at least in some particular, with transient social and economic conditions.

The growing of tobacco, cotton, and other clean-cultivated crops for a long period without the incorporation of organic matter has impaired the productivity of many of the soils. Leaching of the organic matter and the soluble plant nutrients is especially noticeable in the soils having sandy surface soils. Since many of the soils of Warren County were cleared of their original hardwood forests, considerable changes have taken place in the surface soil, because of sheet erosion. Both sheet and gully erosion have been and still are active on the more sloping areas under clean cultivation. Many of the steep slopes never should have been cleared, or, if cleared, they should have been seeded to pasture grasses.

About 28 percent of the land in this county is under cultivation and about 14 percent in pasture. The rest for the most part supports a second growth of shortleaf pine, but in the last few years many fields have been abandoned and are now grown up to broomsedge, briers, and young old-field pine.

A few of the farmers have abandoned the growing of tobacco and are raising cattle. By keeping the land in grasses or legumes, the soil is gradually being improved. From 1929 to 1939 the acreage in hay crops was greatly increased. There has been a large increase in the acreages in wheat and tobacco and a reduction in the acreages in cotton. More leguminous crops and hay crops are now grown than ever before in the history of the county. The production of these crops, together with an increased acreage in corn, is bringing the farmers nearer to a self-sufficient and diversified agriculture. They are gradually improving their soils and giving more consideration to the run-off of the rain water and to the conservation of their soils. Lespedeza is becoming more and more popular, and this is a good crop for many of the soils in Warren County.

All the soils range from acid to very strongly acid in reaction. Applications of 1 to 2 tons an acre of lime will be beneficial to all crops, especially leguminous crops.

Table 6 gives the results of pH determinations on samples of Appling sandy loam and Durham sandy loam.

[4] This section, except the first part ending with table 6, was written by C. B. Williams, agronomist, North Carolina Agricultural Experiment Station.

TABLE 6.—pH *determination on Appling sandy loam and Durham sandy loam*[1]

Soil type and sample No.	Depth	pH	Soil type and sample No.	Depth	pH
Appling sandy loam:	*Inches*		Durham sandy loam:	*Inches*	
237401	0–1	4.7	237415	0–3	4.6
237402	1–8	5.0	237416	3–12	4.8
237403	8–11	5.1	237417	12–28	4.9
237404	11–20	5.1	237418	28–42	4.9
237405	20–38	5.2			
237406	38–50	5.0			

[1] Although these samples were taken in Franklin County, N. C., they apply equally well to those soils in Warren County. Franklin County borders Warren County on the south. These determinations were made by the hydrogen-electrode method by E. H. Bailey, associate soil technologist, Division of Soil Survey.

Many farmers in Warren County recognize differences in soils and grow those crops to which the soils are best adapted. Experience has taught them that the light-colored soils are the best for the production of flue-cured tobacco and the red soils are best adapted for the production of small grains and other crops.

Carefully conducted field experiments have been made by the North Carolina Agricultural Experiment Station on many soil types in the State, in order to determine the best fertilizer treatment for different crops. Data applicable to several soils in Warren County are given in table 7.

TABLE 7.—*Recommendations covering the use of fertilizers for the leading crops on the principal soils of Warren County, N. C.*

Soil type	Fertilizer recommended for—			
	Corn	Cotton	Tobacco	Wheat
	Pounds per acre	*Pounds per acre*	*Pounds per acre*	*Pounds per acre*
Cecil sandy loam Cecil fine sandy loam Cecil fine sandy loam, eroded phase.	250 to 400 of 4–10–4.	400 to 600 of 4–10–4	800 to 1,000 of 3–10–6.	250 to 400 of 4–10–4 or 4–12–4.
Appling sandy loam Appling fine sandy loam. Durham sandy loam Durham fine sandy loam.	400 of 4–8–4 with side application of 100 of nitrate of soda or sulfate of ammonia when about knee to waist high.	500 to 600 of 4–8–4 and 100 of nitrate of soda or sulfate of ammonia after chopping and before the first cultivation.	1,000 of 3–8–6.	400 of 4–8–4 and 100 of nitrate of soda or sulfate of ammonia when the wheat is beginning to send up stems for the formation of seed heads in the spring.

For potatoes the land should be fertilized with 800 to 1,000 pounds of 5–8–6 fertilizer to the acre, and for sweetpotatoes, 600 to 800 pounds of 3–8–8. Good growth of legumes may be obtained by an application of 200 to 400 pounds of 2–10–4, 0–10–6, 0–14–6 fertilizer and 1,000 to 2,000 pounds of ground limestone. Land in grasses should receive 300 to 500 pounds of 4–10–4 or 4–12–4 fertilizer and 1,000 to 2,000 pounds of ground limestone. For cantaloups, the Cecil soils should receive 400 to 600 pounds of 3–10–6 fertilizer and the Appling and Durham soils 400 to 600 pounds of 3–8–6.

On many soils and for many crops the use of lime will be necessary for most profitable results. Lime is not everywhere needed for tobacco; but where it is needed the form recommended is dolomitic limestone if the fertilizers do not contain sufficient available magnesia to

meet the requirements of the crop. For best results the limestone should be broadcast at the rate of about 1 ton to the acre (if no application has been made before). If applied in the drill, it should be added to the land 60 days before transplanting tobacco, at the rate of about 300 pounds per acre. Before making a second application the soil should be tested for acidity. If the pH value of the soil is between 5.5 and 6.0, no limestone should be applied; and if it is above 6.0, tobacco plants should not be put out on the land, because of the danger of infection from black root rot.

Experiments with flue-cured tobacco have shown that best stands and highest returns are usually obtained when the fertilizer is placed about 2½ inches on each side of the row and about an inch below the root crown of the plants.

For all crops, when more than 500 pounds of fertilizer to the acre is applied in the drill, it is usually best to distribute the fertilizer about 10 days before planting and to mix it thoroughly with the soil in the drill furrow.

Following is a list of the highest yielding varieties of the crops recommended as adapted to Warren County soils: Corn—Jarvis Golden Prolific, Weekley Improved, Cocke Prolific, Latham Double, Indian Chief, and Biggs Two-Ear. Cotton—Coker 100 (strains 2 and 3), Delta & Pine Land-12, and Stoneville-2B. Tobacco—Jamaica, Virginia Bright Leaf, Gold Dollar, White-Stem Orinoco, and Bonanza. Wheat—Fulcaster, Carala, and Purplestraw. Soybeans, for seed and soil improvement—Wood's Yellow, Mammoth Yellow, Tokyo, and Herman; for hay—Laredo, Otootan, and Clemson. Clover—crimson, red, and white. Lespedeza—Korean. Vetch—hairy.

Most of the farmers do not follow any definite system of crop rotation. On may farms cotton follows cotton or tobacco follows tobacco year after year. The following 3-year rotation is suggested for the soils on farms devoted mainly to cotton: First year—corn (grain) and soybeans and oats or barley in fall; second year—oats or barley (grain) and lespedeza (turned under) after or without harvesting seed; third year—cotton followed by vetch or crimson clover to be turned under. The following 3-year rotation is suggested for tobacco farms: First year—tobacco and crimson clover or vetch in fall to be turned under in spring; second year—corn (grain) and wheat, oats, or Abruzzi rye in fall; third year—wheat, oats, or rye, the latter to be turned under in spring.

For well-drained fine-textured soils, the following pasture mixture per acre is recommended: Kentucky bluegrass, 4 pounds; redtop, 5 pounds; white clover, 5 pounds; orchard grass, 8 pounds; tall meadow grass, 4 pounds; Dallis grass, 4 pounds; alsike clover, 2 pounds; and lespedeza, 8 pounds. For soils without good drainage, the following mixture is suited: Kentucky bluegrass, 4 pounds; redtop, 5 pounds; white clover, 5 pounds; orchard grass, 8 pounds; Dallis grass, 4 pounds; and lespedeza, 10 pounds.

Most of the soils of the uplands are badly in need of organic matter, as indicated by their dominantly light color. This lack may be best supplied by growing and turning under leguminous crops, such as crimson clover, vetch, soybeans, cowpeas, and lespedeza. If these are cut for hay, little organic matter is left for turning under; but if

the seed is harvested and the residue plowed into the land, an organic-matter content and nitrogen supply of the soil will be built up materially, resulting in an improvement in the productive capacity of the soil.

More legumes should be grown for soil improvement, for seed, and for hay. All available manure produced on the farms should be carefully conserved and returned to the land. If these two practices are followed, the percentage of nitrogen in the commercial fertilizers used may safely be reduced. Another beneficial effect from such practices would be the improvement of the water-absorptive and water-holding capacity of the soils, which will enable crops to make maximum growth during dry periods. Furthermore, erosion would be checked to a considerable extent.

Sheet erosion, or removal of the surface soil, is very severe over most of the county. In many places gullying is active, even where the land is only gently sloping. To check this erosion, strip farming should be practiced in connection with properly built and maintained terraces; that is, there should be a strip, above and below the terraces, of close-growing crops, such as clover or lespedeza. Somewhat gradually deepening the plowing when the land is broken and more thorough preparation of the seedbed will usually prove beneficial. If the soil were plowed to a greater depth than at present, more of the rain water falling on the fields would soak into the soil instead of running off and taking with it valuable surface soil as it does now in many places.

The machinery on the average farm includes a two-horse turning plow, one-horse turning plow, cotton planter, corn planter, grain drill, fertilizer distributor, stalk cutter, disk harrow, spike-tooth harrow, cultivators, and hay rake. A few farms have tractors, manure spreaders, and grain harvesters.

Following is a list of publications giving useful information regarding the cultivation of the soils in Warren County. This list is furnished by the Agronomy Department of the North Carolina State College of Agriculture and Engineering, Raleigh, N. C.

North Carolina State College of Agriculture and Engineering Extension Circulars 127, Soybean Growing in North Carolina; and 222, Terracing to Reduce Erosion.

North Carolina State College of Agriculture and Engineering Extension Folders 8, Tobacco Plant Beds; and 9, Growing Quality Tobacco.

North Carolina Agricultural Experiment Station Bulletin 293, Agricultural Classification and Evaluation of North Carolina Soils.

North Carolina Agricultural Experiment Station Agronomy Information Circulars 116, Approved Fertilizers for Different Crops Grown in North Carolina; and 127, Flue-cured Tobacco Fertilizer Recommendations for 1941.

MORPHOLOGY AND GENESIS OF SOILS

Soil is the product of the forces of weathering and soil development acting on the materials deposited or accumulated by geologic agencies. The characteristics of the soil at any given point depend on (1) the physical and mineralogical composition of the parent material, (2) the climate under which the soil material has accumulated and existed since accumulation, (3) the plant and animal life in and on the soil, (4) the relief, or lay of the land, and (5) the length of time the forces of development have acted on the material.

External climate is less important in its effects on soil development than is internal soil climate, which depends not only on temperature, rainfall, and humidity, but on the physical characteristics of the soil or soil material and the relief, which, in turn, strongly influences drainage, aeration, run-off, erosion, and exposure to sun and wind.

Warren County is on the eastern edge of the Piedmont Plateau. It is in the region of Red and Yellow Podzolic soils of the United States. Practically all of the upland is naturally well drained, as it ranges in relief from undulating or gently sloping to gently rolling or hilly. The elevation ranges from about 300 to 450 feet above sea level.

The soils have developed under a forest cover consisting mainly of deciduous trees, principally oaks, together with some hickory, tuliptree, and conifers. The soils are dominantly light in color, ranging from light gray or pale yellow to reddish brown in the surface layers. The conditions under which they have formed were not favorable for the accumulation of any large quantity of vegetable matter in the soils. In the original forested areas a thin layer of leafmold covers the surface where it has not been burned, and a comparatively small quantity of organic matter is mixed with the topmost 1 to 3 inches of the surface soil. The small quantity of organic matter originally present was soon lost where the soils were devoted to clean-cultivated crops.

Because of the moderately heavy rainfall and the warm temperature, leaching and erosion are two factors in active operation on the surface soils during the greater part of the year, except for short periods in the winter when the ground is frozen to a depth of a few inches. In many places the original normal soil profile has been destroyed and the A horizon has been removed by sheet erosion, leaving dominantly BC soils. This is particularly true on the more sloping or hilly areas that have been under clean cultivation for a long time. A large part of the soluble plant nutrients has been removed, as these nutrients were contained in the fine materials and organic matter originally present in the A horizon. In the soil-forming processes some of the finer materials have been carried away through erosion of the surface soil, and some have been carried down and deposited in the B horizon. In the normally developed soils of the county the A horizon is highly eluviated, whereas the B horizon is rather strongly illuviated. The weathered parent material is variable from place to place in color and texture, but it is dominantly lighter in texture than the B horizon and heavier than the A horizon.

The principal rock formations underlying the soils of Warren County are granite, gneiss, and schist. In a few places there are small areas of dark basic rock; and in some places along the eastern border it is somewhat difficult to distinguish between the fine-grained schist and the so-called Carolina slates (chloritic and argillaceous schists), which occur only a short distance to the east of this county. The rocks have become disintegrated and partly decomposed to a depth ranging from a few to 40 or more feet, but in most places the thickness of the solum ranges from about 2½ to 5 feet. There is no uniformity in the color, texture, or structure of the disintegrated and partly decomposed rock that underlies the heavy and well-oxidized B horizon. Angular fragments of quartz are present on the surface

in a few places, and veins of quartz occur here and there throughout the solum and the disintegrated rock material. Bedrock, particularly granite, lies near the surface in many places. A definite relation exists between the texture of the rocks and the resultant soils. All the very fine textured soils are underlain by schist.

The soil-building processes have acted on the weathered material from the underlying rocks and have produced the various soils of the uplands. These comprise the soils of the Cecil, Appling, Durham, Helena, Wilkes, and Worsham series. Along practically all of the streams are narrow strips of recent alluvium (Congaree and Wehadkee), and along some of the larger creeks and the Roanoke River are small areas of old alluvium (Altavista). With the exception of the alluvium on the terraces, all the material is so recent that no normal soil profile has developed. The material in the first bottoms is constantly being added to by each overflow of the streams.

There are two important groups of soils in the county. The first comprises the soils that have a normal or mature profile. Cecil sandy loam, Cecil fine sandy loam, Appling sandy loam, Appling fine sandy loam, Durham sandy loam, and Durham fine sandy loam may be considered the normally developed soils. These soils express the climatic influence on the weathered products of the parent materials.

Following is a description of a profile of Cecil sandy loam, a characteristic Red Podzolic soil, 1¾ miles northwest of Axtell:

1. 0 to 5 inches, grayish-yellow friable sandy loam.
2. 5 to 7 inches, reddish-yellow friable sandy clay.
3. 7 to 35 inches, stiff brittle red clay containing a small quantity of mica flakes. Under normal moisture conditions this material breaks into irregular-shaped lumps that can be crushed easily into smaller crumb aggregates. Some small scales of mica are present.
4. 35 to 50 inches, light-red friable clay containing yellow and white mottles and small mica scales.
5. 50 inches +, mottled or mingled light-red, white, and yellow soft disintegrated material derived from granite.

Cecil fine sandy loam and Cecil very fine sandy loam differ from Cecil sandy loam essentially in texture. Cecil clay loam in many places once had a covering of sandy loam or fine sandy loam, but the greater part of the original surface soil has been removed by sheet erosion.

Mechanical analyses of Cecil sandy loam and Cecil very fine sandy loam are given in table 8.

TABLE 8.—*Mechanical analyses of Cecil sandy loam and Cecil very fine sandy loam in Warren County, N. C.*

Soil type and sample No.	Depth	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
Cecil sandy loam:	*Inches*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
239401	0–5	13.5	20.5	12.9	24.3	9.5	13.5	5.8
239402	5–7	7.0	14.0	11.5	21.2	7.3	21.4	17.6
239403	7–35	.5	3.6	6.7	14.5	6.1	11.8	56.8
239404	35+	12.9	17.1	7.0	12.3	9.0	15.4	26.3
Cecil very fine sandy loam:								
239413	0–5	.6	3.1	5.9	20.1	24.2	33.9	12.2
239414	5–8	.9	1.4	2.7	12.6	23.0	40.7	18.7
239415	8–40	.4	.4	.9	3.4	15.8	41.5	37.6
239416	40+	.9	2.1	2.1	8.6	28.4	41.4	16.5

Following is a description of a profile of Appling sandy loam northwest of Warren Plains:

1. 0 to 4 inches, grayish-yellow mellow sandy loam.
2. 4 to 9 inches, pale-yellow friable sandy loam.
3. 9 to 11 inches, brownish-yellow friable sandy clay.
4. 11 to 23 inches, yellowish-brown or reddish-yellow stiff brittle clay. This clay under normal moisture conditions breaks into irregular-shaped lumps that can be crushed easily into a friable mass of small crumb aggregates.
5. 23 to 40 inches, yellowish-red mottled with yellow and white friable clay containing small mica scales.
6. 40 inches +, mingled or mottled yellow, white, and reddish-yellow disintegrated and partly decomposed material derived from granite.

With the exception of Appling sandy loam, gravelly phase, the other members of the Appling series are not essentially different from Appling sandy loam except in texture. The finer material influences drainage to a slight extent. The Appling soils are intermediate in color of the B horizon between the red B horizon of the Cecil and yellow B horizon of the Durham.

The soils of the Durham series are characterized by a light-gray or yellowish-gray A horizon and a yellow B horizon of moderately friable clay containing a noticeable quantity of sand particles and, in some places, mica. The B horizon of the Durham is generally not quite so heavy as that of the Cecil or Appling. The solum is shallower over the disintegrated rock than is the solum of the Cecil.

Table 9 gives a chemical analysis of Durham fine sandy loam from Rockingham County, N. C., which, however, is descriptive of this soil as developed in Warren County.

TABLE 9.—*Chemical composition of Durham fine sandy loam*[1]

Sample No.	Depth	SiO_2	TiO_2	Fe_2O_3	Al_2O_3	MnO	CaO	MgO	K_2O	Na_2O	P_2O_5	SO_3	Ignition loss	N
	Inches	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
32381	0–1	75.83	0.21	1.07	9.64	0.051	0.07	0.02	5.05	0.97	0.03	0.06	6.91	0.125
32382	2–12	79.17	.23	1.60	9.89	.030	.70	.06	5.08	1.16	.06	.02	2.18	.030
32383	13–20	61.46	.32	4.30	21.72	.020	.20	.10	3.53	1.04	.05	.03	7.57	.020
32384	21–44	65.22	.26	3.32	19.43	.030	.20	.07	4.45	1.70	.05	.01	6.02	.000
32386-8	61–180	72.61	.19	2.08	14.78	.040	.26	.07	5.45	2.36	.03	.03	2.93	.000

[1] Collected by Mark Baldwin and E. D. Fowler, about 3 miles northeast of Reidsville in Rockingham County, N. C. Analyzed by G. Edgington. Table taken from p. 59 of MARBUT, C. F. SOILS OF THE UNITED STATES. U. S. Dept. Agr. Atlas of Amer. Agr., pt. 3, 8, 98 pp., illus. 1935.

The rest of the soils do not have normal development of the soil profile, owing to imperfect drainage, steepness of slope, or other unfavorable conditions. Helena fine sandy loam differs essentially from the Appling soils in that the B horizon is mottled light-gray and yellow or brown heavy slightly plastic clay or heavy plastic sandy clay. It has developed from aplitic granite, and in places this rock is cut by dikes of dark basic rock. The Wilkes soil represents a soil condition rather than definite development of a profile. The small areas of Worsham soils constitute the only poorly drained soils of the uplands in this county. In places this soil is modified by colluvial material.

SUMMARY

Warren County is in the northeastern part of North Carolina, bordering the North Carolina-Virginia State line. Warrenton, the county seat, is about 50 miles northeast of Raleigh, the State capital. The county has an area of 443 square miles or 283,520 acres. The climate is oceanic. The summers are long and usually rather hot, and the winters are short and comparatively mild. The average frost-free season for the tenderest vegetation is 204 days. The relief ranges from undulating and gently sloping or gently rolling to rolling and strongly rolling as the streams or first bottoms are approached. Good natural surface and internal drainage prevail throughout practically all of the uplands, but drainage on the first bottoms ranges from very poor to good.

The surface soils are dominantly sandy and light colored, and they contain only a small quantity of organic matter. The subsoils are dominantly clay, which ranges in color from yellow to red. All the soils are acid to strongly acid in reaction where not limed recently. The soils of the uplands have developed through the soil-forming processes from the weathered products of granite, gneiss, and schist. The various textures of the soil bear a close relationship to the texture of the underlying rock formations; that is, Cecil, Appling, and Durham sandy loams are underlain by granite and gneiss, whereas the fine sandy loams and very fine sandy loams are underlain by fine-grained gneiss and schist.

The most important and extensive soils in Warren County have gray or grayish-yellow sandy surface soils. These are the sandy members of the Durham, Appling, Cecil, and Helena series. These soils dominate the agriculture of the county. The Durham and some of the Appling soils are the best in the Piedmont Plateau for the production of bright-leaf tobacco.

Soils with red clay loam surface soils, or the so-called red land of the county, including Cecil clay loam and Cecil clay loam, hilly phase, are important soils and are used principally for the production of corn, small grains, cotton, clovers, and hay. Land of the hilly phase is, in most places, too steep for clean-cultivated crops and should be in pasture grasses or forests. Wilkes sandy loam is suitable mainly for forestry, whereas Worsham sandy loam is admirably suited for pasturage. The Congaree soils, occurring in the first bottoms, are inherently the strongest soils in the county and are well suited to the production of corn and hay crops. Associated with the Congaree soils are the Wehadkee soils and alluvial soils (Congaree soil material). These soils generally are poorly drained but can be used advantageously for summer pasture.

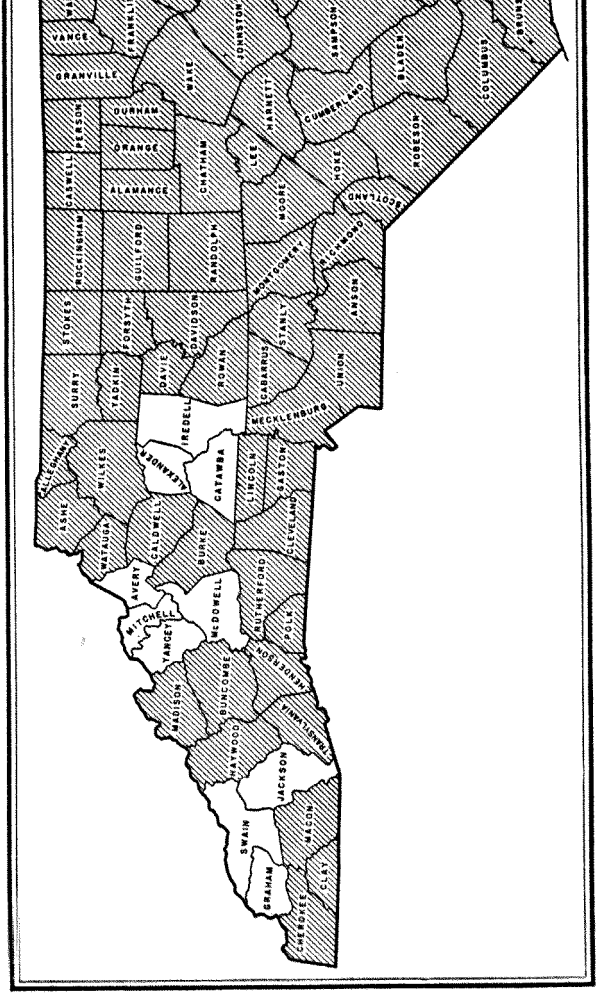
On the more sloping and steeper areas that have been under cultivation to clean-cultivated crops the soils have undergone considerable sheet erosion, and much of the original sandy surface soil has been removed. This type of erosion can be controlled in large measure by the construction of proper terraces, by strip farming, and by seeding the areas to close-growing crops, especially lespedeza and kudzu.

The agriculture of Warren County consists of the production of tobacco, cotton, and some cantaloups, as cash crops, and of corn,

small grains, hay, and garden vegetables as subsistence crops. Corn covers by far the largest acreage. Tobacco and cotton are the main cash crops, and on these crops depends the economic condition of the majority of the farmers. Both the climate and the soils are favorable for the production of bright-leaf tobacco, cotton, peanuts, fruits, sorgo, hay crops, and garden vegetables.

Most of the soils can be built up to a fair and even high state of productivity by applying lime and phosphate, by growing and turning under leguminous crops, and by practicing a definite rotation. Some of the so-called worn-out or abandoned fields can be reclaimed by terracing, strip farming, and growing lespedeza and other hay crops.

○



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SOIL MAP
WARREN COUNTY
NORTH CAROLINA

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION
I. O. SCHAUB, ACTING DIRECTOR
C. B. WILLIAMS, IN CHARGE SOIL SURVEY
NORTH CAROLINA DEPARTMENT OF AGRICULTURE
W. KERR SCOTT, COMMISSIONER

CONVENTIONAL SIGNS

CULTURE
(Printed in black)

City or Village, Roads, Buildings, Wharves, Jetties, Breakwater, Levee, Lighthouse, Fort

Secondary roads and Trails

Railroads Steam and Electric

Bridges, Ferry

R.R. Crossings, Tunnel

Ford, Dam, Sawmill, Windmill

Boundary lines

School, Church, Creamery, Cemeteries

Boundary lines

Triangulation station, Boundary monument, Oil or Gas wells

U.S. Township and Section lines, Recovered corners

Forest fire station, Airway beacon, Oil or Gas tanks

Transmission line, Oil or Gas pipe line

Mine or Quarry, Rock outcrop, Made land

Soil boundaries, Stony, Gravelly and Cherty areas

RELIEF
(Printed in brown or black)

Contours, Depression contours

Prominent hills, Mountain peaks

Sand, Wash, and Sand dunes

Bluff, Escarpment, Mine dumps

DRAINAGE
(Printed in blue)

Streams, Springs, Wells, Flowing wells

Lakes, Ponds, Intermittent lakes

Unsurveyed and Intermittent streams

Water-pipe lines, Canals, Ditches, Flumes

Swamp, Salt marshes

Submerged marsh, Tidal flats

The above signs are in current use on the soil maps. Variations from this usage appear in some maps of earlier dates.

LEGEND

SOILS OF THE SMOOTH TO UNDULATING UPLANDS

GRAY SURFACE SOILS AND RED SUBSOILS

Cecil sandy loam — Cs	Appling sandy loam — Ap
Cecil fine sandy loam — Cf	Appling fine sandy loam — Af
Cecil very fine sandy loam — Cv	Appling very fine sandy loam — Av

GRAY SURFACE SOILS AND YELLOWISH-BROWN TO YELLOWISH-RED SUBSOILS

LIGHT-GRAY SURFACE SOILS AND YELLOW SUBSOILS

Durham sandy loam — Dl	Worsham sandy loam — Wy
Durham fine sandy loam — Df	

DARK-GRAY POORLY DRAINED SOILS

SOILS OF THE SLOPING TO HILLY UPLANDS

GRAY OR RED SURFACE SOILS AND RED SUBSOILS

Cecil fine sandy loam, Eroded phase — Cfr	Appling sandy loam — Apg, Gravelly phase
Cecil clay loam — Cc	Appling sandy loam — Apx, Slope phase
Cecil clay loam — Ccl, Hilly phase	Helena fine sandy loam — Hf

GRAY SURFACE SOILS AND YELLOWISH-RED SUBSOILS

RED SURFACE SOILS AND RED SUBSOILS

GRAYISH-YELLOW SURFACE SOILS AND PLASTIC MOTTLED SUBSOILS

Wilkes sandy loam — Ws	

VARIABLE AND SPALLOW SOILS

SOILS OF THE TERRACES
(SECOND BOTTOMS)

Altavista fine sandy loam — Al

SOILS OF THE FIRST BOTTOMS

WELL DRAINED

Congaree fine sand — Ce	Alluvial soils, Congaree soil material — A
Congaree silt loam — Cl	Wehadkee fine sandy loam — Wf
Congaree silty clay loam — Co	Wehadkee silt loam — Wl

POORLY DRAINED

W. Edward Hearn, Inspector, District 2.
Soils surveyed by W. A. Davis, North Carolina Agricultural Experiment Station and North Carolina Department of Agriculture, in charge, and K. V. Goodman, A. J. Vessel and W. J. Moran, U. S. Department of Agriculture.

Scale 1 inch = 1 mile
1 ½ 0 1 2 3 4 Miles

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Polyconic projection, 1927 North American Datum.
Horizontal control by U. S. G. S., and U. S. C. and G. S.
Base map in part from U. S. Geological Survey Sheets.
10 000 foot grid based upon North Carolina system of plane coordinates.
Surveyed in 1934-38. Series 1938.